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THESIS

AN ANALYSIS OF NON-INTEGERIZING THE AIRCRAFT ENGINES COST EFFECTIVENESS ANALYSIS SPREADSHEET MODEL (CEAMOD Version 2.0)

by

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December, 1993

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This thesis investigated the effect of integerization in the Cost Effectiveness Analysis Spreadsheet Model (CEAMOD Version 2.0) used by the Navy and the Air Force for decision-making in their aircraft engine Component Improvement Programs (CIP). A non-integerized model was developed and sensitivity analysis was performed to determine the cost drivers of the revised model. Three major cost drivers were then utilized as sensitivity analysis tools for comparing the decision values obtained from the current model with those obtained from the revised model. The author concluded that while the non-integerized CEAMOD is more theoretically correct, it would not lead to different decisions than CEAMOD Version 2.0.

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An Analysis of Non-Integerizing the Aircraft Engines Cost Effectiveness Analysis Spreadsheet Model (CEAMOD Version 2.0)

by

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ABSTRACT

This thesis investigated the effect of integerization in the Cost Effectiveness Analysis Spreadsheet Model (CEAMOD Version 2.0) used by the Navy and the Air Force for decision-making in their aircraft engine Component Improvement Programs (CIP). A non-integerized model was developed and sensitivity analysis was performed to determine the cost drivers of the revised model. Three major cost drivers were then utilized as sensitivity analysis tools for comparing the decision values obtained from the current model with those obtained from the revised model. The author concluded that while the non-integerized CEAMOD is more theoretically correct, it would not lead to different decisions than CEAMOD Version 2.0.

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I. INTRODUCTION

A. BACKGROUND

This thesis examines a variation of the Cost Effectiveness Analysis Spreadsheet Model (CEAMOD) recently approved by the Navy and the Air Force for use in their aircraft engine Component Improvement Programs (CIP).

The stated purposes [Ref. 1] of CIP are:

- maintain an engine design which allows the maximum aircraft availability at the lowest total cost to the government (primarily production and support cost);
- correct, as rapidly as possible, any design inadequacy which adversely affects safety-of-flight; and
- correct any design inadequacy which causes unsatisfactory engine operation or adversely affects maintainability and logistic support in service.

Aircraft engine manufacturers may cite one or more of these three purposes as the justification for a CIP proposal. The CEAMOD is a tool to be used by the manufacturers in submitting an Engineering Change Proposal (ECP) to the Navy or the Air Force.

This thesis continues the evaluation of the structure of CEAMOD begun at the Naval Postgraduate School two years ago and reported in theses written by Clague, Davis, Borer and Crowder. The most recent update of the CEAMOD (Version 2.0,

written in EXCEL 4.0 for Windows, July 1993) was used in the research.

B. OBJECTIVE

The specific objective of this thesis is to investigate those areas of the CEAMOD where integerization (rounding off of fractional values to whole numbers) has been incorporated into the model. The reason for doing so is to determine if integerization gives a significantly different expected life cycle cost result than non-integerization. In expected value models, non-integerization is the theoretically correct approach.

C. SCOPE

The scope of this thesis is limited to an analysis of CEAMOD Version 2.0 using a single trial data base provided by General Electric. The basic assumptions of the model and its structure were not questioned. Formulas in the model were analyzed only to determine if they were written so as to accurately calculate the values they were intended to compute.

D. METHODOLOGY

The methodology employed for conducting this research involved reviewing previous theses analyzing the CEAMOD, reviewing minutes of the CEA Users' Group meetings, reviewing model documentation written by Pratt & Whitney, and examining every mathematical formula throughout the model. A revised

version of CEAMOD 2.0 in which integerization has been eliminated was then developed and programmed in EXCEL. (This thesis provides documentation for that revised model.) Sensitivity analyses were then conducted first to determine the cost drivers of Version 2.0, and then to determine if these cost drivers remained the same in the non-integerized revision to the model. Follow-on analysis consisted of varying the cost drivers through a range of values and then comparing the results obtained from the current and revised versions of the model.

E. ORGANIZATION OF THE THESIS

Chapter II provides a background of the CEAMOD, including a brief history of model development, assumptions inherent in the model and an outline of the format of CEAMOD. Chapter III identifies the data fields which were changed from non-integers to non-integers. Chapter IV presents a sensitivity analysis of the non-integerized CEAMOD conducted to identify major cost drivers of the model, and compares the outputs with those of the integerized version. Chapter V provides a summary, conclusions and recommendations on the outcome of the research.

II. BACKGROUND OF THE CEAMOD

A. HISTORICAL DEVELOPMENT

The Cost Effectiveness Analysis Spreadsheet Model (CEAMOD) was originally developed by Pratt & Whitney, a leading aircraft engine manufacturer, based on an initial spreadsheet structural framework proposed by Larry Briskin of the Air Force. Pratt & Whitney's first version of CEAMOD was designed to be run using the DYNAPLAN spreadsheet on a mainframe computer. General Electric later received a copy of the DYNAPLAN-based model, downloaded it to an IBM personal computer, and converted the model to run using LOTUS 123 software. The Navy became interested in the model shortly after General Electric developed the conversion. As a consequence, the Air Force and the Navy formed the CEA Users' Group. The group's initial purpose was to develop a detailed understanding of the model in order to decide if its use should be formally implemented as part of the CIP decision process. The group then recommended model changes and finally formally approved Version 2.0 as the baseline model to be used in future ECP justifications by aircraft engine manufacturers. Since inception of the CEA Users' Group, three updated LOTUS 123 versions of CEAMOD have been released - Versions 1.3, 1.4,

and 1.5. Previous Naval Postgraduate thesis research has analyzed these LOTUS 123 versions of the model.

As part of the Version 2.0 evolution, the CEA Users' Group specified that the CEAMOD be converted from LOTUS 123 to EXCEL because EXCEL was replacing LOTUS as the approved spreadsheet software in the Air Force and the Navy. In May of 1993, the Users' Group met at the Naval Postgraduate School to decide on the final model changes before release of Version 2.0. Pratt & Whitney incorporated the changes and completed the conversion to EXCEL for Windows. CEAMOD Version 2.0 was released at the end of July 1993. This thesis and concurrent thesis work being conducted by LCDR Ross Reeves are the Naval Postgraduate School's first research efforts in analyzing the EXCEL version of the CEAMOD.

B. BASIC ASSUMPTIONS OF THE MODEL

As stated in Chapter I, CEAMOD is the approved model for analyzing an Engineering Change Proposal (ECP) arising from the Component Improvement Program (CIP). Specifically, the model calculates the expected value of changes in logistics support costs over an engine's remaining life cycle as a result of adoption and incorporation of an ECP for an engine component. In an ideal scenario, the operational and logistics support savings as a consequence of implementing an ECP should outweigh the costs of implementation

[Ref. 2:p. I-1]. The accuracy of the model becomes increasingly critical as the expected savings approach zero.

The life cycle cost analysis performed by CEAMOD excludes various "front-end" costs which could give a truer picture of an ECP's costs/benefits. These costs include research, design, and testing costs, engineering data costs and program management costs [Ref. 3:p, 6]. Another limitation of the model's cost analysis was noted by Clague, who stated,

> The model determines costs by using the annual average number of engines receiving the ECP vice costs derived from the actual number of engines receiving the ECP throughout the year. This gives a lag to costs and may show no flight hours the last year, but there still may be engines being supported. [Ref. 3:p. 6]

CEAMOD Version 2.0 maintains the assumption used in all previous versions that the number of engine failures in a year are Poisson distributed. A Poisson distribution assumes a constant failure rate. Incorporation of the Poisson distribution in CEAMOD does not allow the engine failure rate profile to assume the shape of the well-known and more realistic "bathtub curve" [Ref. 4:p. 315]. Use of the Weibull distribution would allow failure rate increases and decreases to be considered in CEAMOD life cycle costing analysis. Research and discussions concerning a change to the use of the Weibull distribution are ongoing among members of the CEA Users' Group, and will be the subject of a future thesis at the Naval Postgraduate School.

Because of the probabilistic nature of engine failures, the number of component/engine failures in a year computed by the model are expected values rather than actual values. It is possible, and indeed quite probable, that these expected failures will be computed out as fractional rather than integer (whole number) values. Since virtually all CEAMOD calculations are themselves expected value computations or are derived from the expected value calculations of failures based on the Poisson distribution, the results of those calculations can be expected to be fractional as well.

All versions of CEAMOD have rounded any fractional expected number of failures calculated using the Poisson distribution. What effect this rounding has on the model's output has been a topic of discussion at the CEA Users' Group meetings. The Naval Postgraduate School agreed to investigate the issue. This thesis provides the results of that investigation.

The current EXCEL 2.0 version of CEAMOD employs extensive use of the truncation (TRUNC) command to integerize expected values which would have otherwise been computed as fractional values. This thesis examined the use of truncation throughout the model and deleted it where deemed appropriate in the developing of the revised, non-integerized version of the model.

C. FORMAT OF CEAMOD VERSION 2.0

EXCEL CEAMOD Version 2.0 consists of a spreadsheet layout which can be viewed using an IBM or other MS-DOS based personal computer which has a Windows application. The layout is comprised of a series of pages containing various spreadsheet columns. These pages and their associated columns are:

- Page 1 - An input page containing Standard Inputs, Task Incorporation Input, Scheduled Input for both the current and proposed engine configurations, Unscheduled Input for current and proposed engine configurations, and Optional Input for current and proposed engine configurations (columns B through G);
- Page 2 - **STANDARD HISTORY FILE** (columns N through W);
- Page 3a - **CURRENT CONFIGURATION** Data (columns BA through BR);
- Page 3b - **CURRENT CONFIGURATION** Cost Data (columns BT through CK);
- Page 4a - **PROPOSED CONFIGURATION** Data (columns CM through DD);
- Page 4b - **PROPOSED CONFIGURATION** Cost Data (columns DF through DW);
- Page 5 - An analysis page comparing costs for the current and proposed engine configurations (columns DY through ED);
- **Summary Page** - (columns EF through EM);
- **Interim Calculations Page** - (columns EO through EW).

The pages listed above are included in the basic CEAMOD Analysis Package printout. The model contains a macro which allows the user to print out this entire package.

CEAMOD Version 2.0 also contains additional data as outlined below. The model's print macro was not written to print these pages so if copies are desired the following printout instructions can be used.

- **Calculated Costs/Event Page** - (columns H through M) To print this page, the user would use Print Area H18:M65.
- **Extension of Page 2** - (columns Y through AD) To print this page, the user would use Print Area Y6:AD54. This page, which prints with no titular heading, contains data which amplifies and is used in conjunction with data presented on Page 2. This page is the equivalent of Page 2 (Ext A) in old LOTUS 123 versions of the model.
- **Extension of Page 2** - (columns AE through AZ) To print this page, the user would use Print Area AE6:AZ54. This page, which prints with no titular heading, contains data which amplifies and is used in conjunction with data presented on Page 2. This page is the equivalent of Page 2 (Ext B) in old LOTUS 123 versions of the model.

III. NON-INTEGERIZATION OF DATA FIELDS

A. METHODOLOGY

The methodology employed for non-integerizing the CEAMOD began with a detailed review of every mathematical formula (equation) used in the spreadsheet model. As formulas were encountered where integerization was applied, an investigation was initiated in an effort to ascertain the intent/need for writing a formula which returned only whole numbers. Of specific interest were instances where integerization was applied to probabilistic processes which would otherwise have returned fractional (non-integerized) results. Columnar and specific cell field formulas qualifying for non-integerization were then re-written to allow for the computation of non-integerized values.

B. NATURE OF FORMULA REVISIONS

Revisions to CEAMOD formulas consisted of two distinct types; those deemed substantive in nature and those accomplished for purposes of consistency and readability. Substantive revisions were those which non-integerized CEAMOD formulas and thus impacted the mathematical calculations of the model. Non-substantive revisions served only cosmetic purposes.

Prior to initiating revisions, the author identified values in the following spreadsheet columns which are "naturally" integers - columns N, O, P, Q, AT, BA, BT, CH, CI, CM, DF, DT and DU. (Columns CH, CI, DT, and DU display "N/A" rather than an integer value if the numerical value calculation in the column is not applicable to the particular Engineering Change Proposal under consideration.) Formulas in these columns were not modified. Additionally, no modifications were made to any column or cell displaying a dollar value. This was the case regardless of whether the monetary value displayed was in whole dollars or in dollars and cents.

C. SUBSTANTIVE REVISIONS

The substantive revisions to CEAMOD are presented below. For each revision, four versions of each formula are presented:

- Cell name version before revision
- Cell reference version before revision
- Cell name version after revision
- Cell reference version after revision

The order of the revision presentations is the same as that in which the columns or individual cell fields are encountered in a progressive tour (left to right, top to bottom) through the model. Individual cell formulas are shown as they appear to the CEAMOD user with formula format, spelling and capitalization in their exact model layout.

Yearly columnar computations are in rows 14 through 46. In the data presented below, the formula for the first year in each column (i.e., row 14) is given. Subsequent entries in each column (rows 15 through 46) merely substitute the appropriate annual data for the year under consideration into the first year's formula.

1. Column S

Column S is **Annual Engine Flight Hours - Fleet.** Formulas in this column calculate the sum of the annual average engine flying hours for all aircraft in the fleet. The cell name version of the formula for S14 is:

=*TRUNC*((*PrevYrEngDelCum*+*CurYrEngDelCum*)/2)*$*EfhYr*

The cell reference version of the formula for S14 is:

=*TRUNC*((*R13*+*R14*)/2)*$*P*$50

Formulas for cells S15 through S46 are similar.

This formula determines the sum of the annual average engine flying hours for all aircraft in the fleet by multiplying the integerized average of the cumulative engine deliveries for the previous year and the current year by the predicted engine flight hours per year input by the user in cell P50.

The revised cell name version of the formula for S14 is:

=((*PrevYrEngDelCum*+*CurYrEngDelCum*)/2)*$*EfhYr*

The revised cell reference version of the formula for S14 is:

=((*R13*+*R14*)/2)*$*P*$50

Formulas for cells S15 through S46 are revised similarly.

The revised formula deletes truncation (TRUNC) from the portion of the formula which averages the cumulative engine deliveries for the previous year and the current year. This revision allows for the annual average engine flying hours for all aircraft in the fleet to be calculated as non-integers (e.g., 11,500.25 hours instead of 11,500 hours).

2. Column T

Column T is **Annual Engine Flight Hours - Average per Engine**. Formulas in this column calculate the average engine flying hours per engine per year. The cell name version of the formula for T14 is:

=*IF*(*CurYrEngDelCum*=0,$*EfhYr*,*AnnualFleetEfh*/*TRUNC*((*CurYrEngDelCum*+*PrevYrEngDelCum*)/2))

The cell reference version of the formula for T14 is:

=*IF*(*R14*=0,$*P*$50,*S14*/*TRUNC*((*R14*+*R13*)/2))

Formulas for cells T15 through T46 are similar.

This IF statement uses the following logic to determine the average engine flying hours per engine per year.

a. If cumulative engine deliveries for the current year is zero (0), average engine flying hours per engine per

year equals the predicted engine flight hours per year input by the user.

b. If cumulative engine deliveries for the current year are not zero (0), average engine flying hours per engine per year equals annual engine flight hours - fleet (the total engine flight hours for all aircraft in the fleet) for the current year divided by the average of the cumulative engine deliveries for the current year and the previous year.

The revised cell name version of the formula for T14 is:

=*IF*(*CurYrEngDelCum*=0,$*EfhYr*,*AnnualFleetEfh*/((*CurYrEngDelCum*+*PrevYrEngDelCum*)/2))

The revised cell reference version of the formula for T14 is:

=*IF*(*R14*=0,$*P*$50,*S14*/((*R14*+*R13*)/2))

Formulas for cells T15 through T46 are revised similarly.

The revised formula deletes truncation from the portion of the formula which averages the cumulative engine deliveries for the current year and the previous year. This revision is necessary due to the revision made to column S. Deletion of truncation here ensures that the value calculated in column T equals the predicted engine flight hours per year input by the user in cell P50. (An IF statement is really not required for this formula; the value computed in column T will always equal the value input by the user in cell P50 under non-integerization.)

3. Column W

Column W is **Attrition - Annual Whole Engines**. Formulas in this column calculate the number of engines lost through attrition each year. The cell name version of the formula for W14 is:

=IF(CurYrAttritCumWholeEng<>PrevYrAttritCumWholeEng, CurYrAttritCumWholeEng-PrevYrAttritCumWholeEng,0)

The cell reference version of the formula for W14 is:

=IF(V14<>V13,V14-V13,0)

Formulas for cells W15 through W46 are similar.

This IF statement uses the following logic to determine the number of engines annually lost through attrition.

a. If the current year's cumulative whole number of engines lost through attrition is not equal to the cumulative whole number of engines lost through attrition in the previous year, then the current year's annual number of engines lost through attrition is the current year's cumulative whole number of engines lost through attrition minus the cumulative whole number of engines lost through attrition in the previous year.

b. If the current year's cumulative whole number of engines lost through attrition is equal to the cumulative whole number of engines lost through attrition in the previous

year, then the current year's annual number of engines lost through attrition is zero (0).

The revised cell name version of the formula for W14 is:

=IF(CurYrAttritCumEng<>PrevYrAttritCumEng,CurYrAttritCumEng-PrevYrAttritCumEng,0)

The revised cell reference version of the formula for W14 is:

=IF(U14<>U13,U14-U13,0)

Formulas for cells W15 through W46 are revised similarly.

The revised formula changes the comparison from the current year's cumulative whole number of engines lost through attrition (column V) to the cumulative number of engines lost through attrition (column U). Column V had been used to integerize the values in column U. By changing the comparison from column V to column U, the current year's annual number of engines lost through attrition calculated by column W becomes a non-integer value. Column V is no longer required in this revised version of CEAMOD.

4. Column Y

Column Y is **Upgraded Engines Done by Attrition.** Formulas in this column calculate the number of engines in each year that will receive the component modification when the attrition incorporation style is selected in cell D9 (i.e., D9=1). The cell name version of the formula for Y14 is:

```
=IF(IncorpStyle=1,MIN(TRUNC(UnschModYrInt*(MoAvailFieldMod/12)*
UnschPctEvtMod+0.5)+TRUNC(ProSchEvtUnmod*SchPctEvtMod*(
MoAvailFieldMod/12)+0.5),TotEngDel-TotEngModProd-PrevYrCumKitInstl,
PrevYrProUnmodEng),0)
```

The cell reference version of the formula for Y14 is:

```
=IF(D9=1,MIN(TRUNC(AW14*P14/12)*D25+0.5)+TRUNC(CU14*D24*(P14/12)+
0.5),Q$48-CN$48-AC13,CO13),0)
```

Formulas for cells Y15 through Y46 are similar.

This IF statement uses the following logic to determine the whole number of engines in each year that are expected to receive the component modification under the attrition incorporation style.

a. If the incorporation style equals 1 (indicating incorporation via attrition), the value placed in the cell is the minimum of the following three computed values:

(1) A whole number obtained by adding the product of the annual integer value of unscheduled incorporation opportunities, the number of available field modification months divided by twelve (12), and the unscheduled percentage of events being modified plus 0.5 to another whole number obtained by multiplying scheduled incorporation events on unmodified engines under the proposed configuration, the scheduled percentage of events being modified, and the number of available field modification months divided by twelve (12) and adding 0.5.

(2) Total number (annual) of engines delivered minus total engines modified in production minus the cumulative number of kits installed in the previous year.

(3) Average number of unmodified engines in the previous year.

b. If the incorporation style does not equal 1, the value placed in the cell is zero (0). The revised cell name version of the formula for Y14 is:

=*IF*(*IncorpStyle*=1,*MIN*((*UnschModYr**(*MoAvailFieldMod*/12)*
UnschPctEvtMod)+(*ProSchEvtUnmod***SchPctEvtMod**(*MoAvailFieldMod*/12)),
TotEngDel-*TotEngModProd*-*PrevYrCumKitInstl*,*PrevYrProUnmodEng*),0)

The revised cell reference version of the formula for Y14 is:

=*IF*(*D9*=1,*MIN*((*AW14***P14*/12)**D25*)+(*CU14***D24**(*P14*/12)),*Q*$48-*CN*$48-*AC13*,
CO13),0)

Formulas for cells Y15 through Y46 are revised similarly.

The revised formula deletes the truncations from the portion of the cell formula which calculates the first of the three values from among which the minimum is chosen. Elimination of truncation allows column Y's calculated values for the number of engines upgraded by attrition to be non-integerized.

The additions of 0.5 (known as the 0.5 rounding rule) were also deleted from the same portion of the cell formula. These additions of 0.5 were intended to work in coordination with the truncations written into the original formula. In his research of CEAMOD, Clague commented on the use of

additions of 0.5 in a formula by stating, "The 0.5 added to...is to help ensure that the final figure for this column is the next higher whole number [Ref. 3:p. 83]." This comment, or words to the same effect, was made by Clague throughout his thesis in describing model formulas where additions of 0.5 were employed. However, a review of the LOTUS 123 and EXCEL 4.0 User's Manual revealed that the formulation of adding 0.5 was incorrect if rounding up was its intended purpose. If a calculated value before addition of 0.5 included a fractional portion that was less than 0.5 (e.g., 40.3), addition of 0.5 would simply increase the fractional portion of the value (40.8). The integer function in LOTUS 123 and the truncation function in EXCEL 4.0 delete or "drop off" any fractional value, thus resulting in a final value (40). Only a number with a fractional portion of 0.5 or larger would be rounded up to the next higher whole number. For example, 40.8 plus 0.5 gives 41.3 and rounding leaves 41.

5. Column Z

Column Z is **Upgraded Engines Done by 1st Opportunity**. Formulas in this column calculate the whole number of engines in each year that will receive the component modification when "Retrofit at 1st Opportunity" is selected as the incorporation style in cell D9 (i.e., D9=2). The cell name version of the formula for Z14 is:

=IF(IncorpStyle=2,MIN(TRUNC(UnschModYrInt(MoAvailFieldMod/*12*)* UnschPctEvtMod*+0.5)+*TRUNC(ProSchEvtUnmod*SchPctEvtMod*(MoAvailFieldMod/*12)+0.5),*TotEngDel-TotEngModProd-PrevYrCumKitInstl, PrevYrProUnmodEng*),0)

The cell reference version of the formula for Z14 is:

*=IF(D9=*2,*MIN(TRUNC(AW14*(P14/*12*)*D25*+0.5)+*TRUNC(CU14*D24*(P14/*12)+0.5),*Q$48-CN$48-AC13,CO13*),0)

Formulas for cells Z15 through Z46 are similar.

This IF statement is exactly the same as that for column Y described above, except that it looks for a 2 (indicating incorporation done at the first opportunity) in cell D9 instead of a 1 (indicating incorporation via attrition).

The revised cell name version of the formula for Z14 is:

*=IF(IncorpStyle=*2,*MIN((UnschModYr*(MoAvailFieldMod/*12*)* UnschPctEvtMod*)+(*ProSchEvtUnmod*SchPctEvtMod*(MoAvailFieldMod/*12)), *TotEngDel-TotEngModProd-PrevYrCumKitInstl,PrevYrProUnmodEng*),0)

The revised cell reference version of the formula for Z14 is:

*=IF(D9=*2,*MIN((AW14*(P14/*12*)*D25*)+(*CU14*D24*(P14/*12)), *Q$48-CN$48-AC13,CO13*),0)

Formulas for cells Z15 through Z46 are revised similarly.

The revised formula deletes the truncations and the additions of 0.5 in the same manner as was done for column Y described above. This revision allows column Z's calculated values for the number of engines upgraded at first opportunity to be non-integerized.

6. Column AA

Column AA is **Upgraded Engines Done by Forced** (retrofit). Formulas in this column calculate the whole number of engines in each year that will receive the component modification when "Forced Retrofit" is selected as the incorporation style in cell D9 (i.e., D9=3). The cell name version of the formula for AA14 is:

=*IF*(*IncorpStyle*=3,*MIN*(*TRUNC*(*ForcedRetroRate**12+0.5)*(*MoAvailFieldMod*/12),*MAX*(*CurYrEngDelCum*-*CurYrEngModProd*-*PrevYrCumKitInstl*,0)),0)

The cell reference version of the formula for AA14 is:

=*IF*(*D9*=3,*MIN*(*TRUNC*(*D12**12+0.5)*(*P14*/12),*MAX*(*R14*-*AB14*-*AC13*,0)),0)

Formulas for cells AA15 through AA46 are similar.

This IF statement uses the following logic to determine the whole number of engines in each year that are expected to receive the component modification under forced retrofit incorporation style.

a. If the incorporation style equals 3 (indicating incorporation via forced retrofit), the value placed in the cell is the minimum of the following two computed values:

(1) A whole number obtained by multiplying the product of the forced retrofit rate times twelve (12) plus 0.5 by the number of available field modification months divided by twelve (12).

(2) The maximum of current year cumulative engine deliveries minus current year upgraded engines modified

in production minus previous year cumulative kits installed, or zero (0).

b. If the incorporation style does not equal 3, the value placed in the cell is zero (0).

The revised cell name version of the formula for AA14 is:

=*IF*(*IncorpStyle*=3,*MIN*((*ForcedRetroRate**12)*(*MoAvailFieldMod*/12),*MAX*(*CurYrEngDelCum*-*CurYrEngModProd*-*PrevYrCumKitInstl*,0)),0)

The revised cell reference version of the formula for AA14 is:

=*IF*(*D9*=3,*MIN*((*D12**12)*(*P14*/12),*MAX*(*R14*-*AB14*-*AC13*,0)),0)

Formulas for cells AA15 through AA46 are revised similarly.

The revised formula deletes truncation and the addition of 0.5 from the first part of the formula. This revision allows column AA's calculated values for the number of engines upgraded via forced retrofit to be non-integerized.

7. Cell AG53

Cell AG53 is **Years/Inspection Interval**. The formula in this cell calculates the length of the inspection interval in years. The cell name version of the formula for AG53 is:

=*TRUNC*($*AI*$52/$*EfhYr*)

The cell reference version of the formula for AG53 is:

=*TRUNC*($*AI*$52/$*P*$50)

The formula in cell AG53 calculates the length of the inspection interval in whole years by dividing the unmodified

side inspection interval in engine flight hours by the number of engine flight hours per year, and then truncating the result. (A side inspection is an inspection incident to a side event. Side event is the terminology used by CEAMOD for an unscheduled engine failure.)

The revised cell name version of the formula for AG53 is:

=(*$AI$52/$EfhYr*)

The revised cell reference version of the formula for AG53 is:

=(*$AI$52/$P$50*)

The revised formula has truncation deleted. This allows the length of the inspection interval to be non-integerized and calculated in less than whole year increments.

8. Cell AG54

Cell AG54 is **Inspections/Year**. The formula in this cell calculates the number of engine inspections per year. The cell name version of the formula for AG54 is:

=*TRUNC*(*$EfhYr/$AI$52*)

The cell reference version of the formula for AG54 is:

=*TRUNC*(*$P$50/$AI$52*)

The formula in cell AG54 calculates the whole number of engine inspections per year by dividing the number of engine flight hours per year by the unmodified side inspection

interval in engine flight hours, and then truncating the result.

The revised cell name version of the formula for AG54 is:

=(\$*EfhYr*/\$*AI*\$52)

The revised cell reference version of the formula for AG54 is:

=(\$*P*\$50/\$*AI*\$52)

The revised formula has truncation deleted. This allows the number of engine inspections per year to be calculated in non-integer increments.

9. Column AM

Column AM is **Current Side Events - Annual Integer.** Formulas in this column calculate the number of side events which are expected to occur for the unmodified engines. The cell name version of the formula for AM14 is:

=*IF*(*CurYrCurEvtCumInt*<>*PrevYrCurEvtCumInt*,*CurYrCurEvtCumInt*-*PrevYrCurEvtCumInt*,0)

The cell reference version of the formula for AM14 is:

=*IF*(*AL14*<>*AL13*,*AL14*-*AL13*,0)

Formulas for cells AM15 through AM46 are similar.

This IF statement uses the following logic to calculate the annual whole number of side events which are expected to occur for unmodified engines.

a. If the cumulative integer value of side events for the current year is not equal to the cumulative integer value of side events for the previous year, the value displayed in the cell is the cumulative integer value of side events for the current year minus the cumulative integer value of side events for the previous year.

b. If the cumulative integer value of side events for the current year is equal to the cumulative integer value of side events for the previous year, the value displayed in the cell is zero (0).

The revised cell name version of the formula for AM14 is:

=*IF*(*CurYrCurEvtCumDec*<>*PrevYrCurEvtCumDec*,*CurYrCurEvtCumDec*-*PrevYrCurEvtCumDec*,0)

The revised cell reference version of the formula for AM14 is:

=*IF*(*AK14*<>*AK13*,*AK14*-*AK13*,0)

Formulas for cells AM15 through AM46 are revised similarly.

The revised formula uses cumulative decimal values of side events (column AK) rather than cumulative integer values of side events (column AL) for computing the annual number of side events which are expected to occur for the unmodified engines. The computed values in column AM are non-integerized. Column AL is no longer required in this revised version of CEAMOD.

10. Column AP

Column AP is **Proposed Side Unmod Events - Annual Integer**. Formulas in this column calculate the number of side events which are expected to occur on unmodified components (i.e., components which have not been replaced by modified components yet) for the proposed configuration engines. The cell name version of the formula for AP14 is:

=IF(CurYrProUnmodEvtCumInt<>PrevYrProUnmodEvtCumInt, CurYrProUnmodEvtCumInt-PrevYrProUnmodEvtCumInt, 0)

The cell reference version of the formula for AP14 is:

*=IF(AO14<>AO13,AO14-AO13,*0)

Formulas for cells AP15 through AP46 are similar.

This IF statement uses the following logic to calculate the annual whole number of side events which are expected to occur on unmodified engines as the proposed configuration changes are being installed on other engines.

a. If the cumulative integer value of side events for the current year is not equal to the cumulative integer value of side events for the previous year, the value displayed in the cell is the cumulative integer value of side events for the current year minus the cumulative integer value of side events for the previous year.

b. If the cumulative integer value of side events for the current year is equal to the cumulative integer value

of side events for the previous year, the value displayed in the cell is zero (0).

The revised cell name version of the formula for AP14 is:

=IF(CurYrProUnmodEvtCumDec<>PrevYrProUnmodEvtCumDec, CurYrProUnmodEvtCumDec-PrevYrProUnmodEvtCumDec,0)

The cell reference version of the formula for AP14 is:

=IF(AN14<>AN13,AN14-AN13,0)

Formulas for cells AP15 through AP46 are revised similarly.

The revised formula uses cumulative decimal values of side events (column AN) rather than cumulative integer values of side events (column AO) for computing the annual number of side events which are expected to occur on unmodified engines as the proposed configuration changes are being installed on other engines. The computed values in column AP are non-integerized. Column AO is no longer required in this revised version of CEAMOD.

11. Column AR

Column AR is **Proposed Side Mod Events - Cumulative Integer**. Formulas in this column calculate the cumulative number of side events which are expected to occur on modified components for the proposed configuration engines. The cell name version of the formula for AR14 is:

=IF(CurUnschEvtRate=ProUnschEvtRate,CurYrCurEvtCumInt-CurYrProUnmodEvtCumInt,TRUNC(CurYrProModEvtCumDec))

The cell reference version of the formula for AR14 is:

=IF(E48=F48,AL14-AO14,TRUNC(AQ14))

Formulas for cells AR15 through AR46 are similar.

This IF statement uses the following logic to calculate the cumulative whole number of side events which are expected to occur on modified components for the proposed configuration engines.

a. If the unscheduled event (failure) rate per 1000 engine flight hours in the current (unmodified engine) configuration is equal to the unscheduled event rate per 1000 engine flight hours in the proposed configuration, the value displayed in the cell is the cumulative integer value of side events (engine failures) for the current configuration minus the cumulative integer value of side events for unmodified components in the proposed configuration.

b. If the unscheduled event rate per 1,000 engine flight hours in the current configuration is not equal to the unscheduled event rate per 1,000 engine flight hours in the proposed configuration, the cumulative decimal value of side events which are expected to occur on modified components for the proposed configuration engines is truncated and the value is placed in the cell.

The revised cell name version of the formula for AR14 is:

=IF(CurUnschEvtRate=ProUnschEvtRate,CurYrCurEvtCumDec-CurYrProUnmodEvtCumDec,(CurYrProModEvtCumDec))

The revised cell reference version of the formula for AR14 is:

=IF(E48=F48,AK14-AN14,AQ14)

Formulas for cells AR15 through AR46 are revised similarly.

As noted above in the discussion of the revisions to columns AM and AP, columns AL and AO, which provide cumulative side event integer values, are not used in this revised CEAMOD. Instead of subtracting the cumulative integer value of side events for unmodified components in the proposed configuration (column AO) from the cumulative integer value of side events for the current configuration (Column AL), the revision subtracts the cumulative decimal value of side events for the current configuration (Column AN) from the cumulative decimal value of side events for unmodified components in the proposed configuration (column AK). Additionally, the revision removes truncation from the cumulative decimal value of side events which are expected to occur on modified components for the proposed configuration engines.

12. Column AS

Column AS is **Proposed Side Mod Events - Annual Decimal**. Formulas in this column calculate the value of the annual number of side events which are expected to occur on

modified components for the proposed configuration engines. The revised formulas in column AR allow the cumulative number of side events which are expected to occur on modified components for the proposed configuration engines to be non-integerized. They also allow the values in column AS to be non-integerized since the formulas in column AS simply compute differences in the cumulative values shown in column AR.

13. Column AW

Column AW is **Unsched Incorporation Opportunities - Annual Integer**. Formulas in this column calculate the expected number of unscheduled side events which would allow for incorporation of the modification. The cell name version of the formula for AW14 is:

=IF(CurYrUnschModOppCumInt<>PrevYrUnschModOppCumInt, CurYrUnschModOppCumInt-PrevYrUnschModOppCumInt,0)

The cell reference version of the formula for AW14 is:

=IF(AV14<>AV13,AV14-AV13,0)

Formulas for cells AW15 through AW46 are similar.

This IF statement uses the following logic to calculate the annual whole number of unscheduled side events which would allow for incorporation of the modification.

a. If the cumulative integer value of unscheduled side events for the current year is not equal to the cumulative integer value of unscheduled side events for the previous year, the value displayed in the cell is the

cumulative integer value of unscheduled side events for the current year minus the cumulative integer value of unscheduled side events for the previous year.

b. If the cumulative integer value of unscheduled side events for the current year is equal to the cumulative integer value of unscheduled side events for the previous year, the value displayed in the cell is zero (0).

The revised cell name version of the formula for AW14 is:

=IF(CurYrUnschModOppCumDec<>PrevYrUnschModOppCumDec, CurYrUnschModOppCumDec-PrevYrUnschModOppCumDec,0)

The revised cell reference version of the formula for AW14 is:

=IF(AU14<>AU13,AU14-AU13,0)

Formulas for cells AW15 through AW46 are revised similarly.

The revised formula uses cumulative decimal values of unscheduled side events (column AU) rather than cumulative integer values of unscheduled side events (column AV) for computing the annual number of unscheduled side events which would allow for incorporation of the modification. The computed values in column AW are non-integerized. Column AV is no longer required in this revised version of CEAMOD.

14. Column BC

Column BC is **Avg. No. Engines - Unmod Engines.** Formulas in this column calculate the average number of

unmodified engines in the fleet each year. The cell name version of the formula for BC14 is:

=*TRUNC*((*CurYrEngDelCum+PrevYrEngDelCum*)/2)

The cell reference version of the formula for BC14 is:

=*TRUNC*((*R14+R13*)/2)

Formulas for cells BC15 through BC46 are similar.

The formula adds the value of the current year cumulative engine deliveries to the value of the previous year cumulative engine deliveries, divides by two, and then truncates the result to compute the whole number value placed in the cell.

The revised cell name version of the formula for BC14 is:

=((*CurYrEngDelCum+PrevYrEngDelCum*)/2)

The revised cell reference version of the formula for BC14 is:

=((*R14+R13*)/2)

Formulas for cells BC15 through BC46 are revised similarly.

The revised formula deletes truncation and allows the value computed for the average whole number of unmodified engines in the fleet each year to be non-integerized.

15. Column BI

Column BI is **Sched. Events - Unmod.** Formulas in this column calculate the annual number of scheduled events for the

unmodified engines. The cell name version of the formula for BI14 is:

=IF(CurYrUnmodEfh=0,0,*IF(CurYr>UnmodSchAvailYr,TRUNC*(0.5+ *CurCalSchMaintInt*CurSchInspEfh*/1000),0))

The cell reference version of the formula for BI14 is:

=IF(BE14=0,0,*IF(BA14>AF14,TRUNC*(0.5+*E33*AJ14*/1000),0))

Formulas for cells BI15 through BI46 are similar.

This IF statement uses the following logic to compute the annual whole number of scheduled events for the unmodified engines.

a. If the value of yearly engine flight hours for unmodified engines in the current year equals zero (0), the value placed in the cell is zero (0).

b. If the value of yearly engine flight hours for unmodified engines in the current year does not equal zero (0), the following IF statement is used to compute the annual whole number of scheduled events for the unmodified engines.

(1) If the current calendar year is greater than the year in which scheduled maintenance inspections of unmodified components are expected to begin under the proposed configuration, the value displayed in the cell is 0.5 added to the truncated integer value of the product of the calculated scheduled maintenance interval rate per 1000 engine flight hours and the number of engine flight hours that are expected to be flown on unmodified engines divided by 1000.

(2) If the current calendar year is not greater than the year in which scheduled maintenance inspections of unmodified components are expected to begin under the proposed configuration, the value displayed in the cell is zero (0).

The revised cell name version of the formula for BI14 is:

=*IF*(*CurYrUnmodEfh*=0,0,*IF*(*CurYr*>*UnmodSchAvailYr*,(*CurCalSchMaintInt***CurSchInspEfh*/1000),0))

The revised cell reference version of the formula for BI14 is:

=*IF*(*BE14*=0,0,*IF*(*BA14*>*AF14*,(*E33***AJ14*/1000),0))

Formulas for cells BI15 through BI46 are revised similarly.

The revision deletes truncation and the addition of 0.5 from the formula. The value computed for the annual number of scheduled events for the unmodified engines is no longer integerized.

16. Column CN

Column CN is **Engines Mod in Prod**. Formulas in this column calculate the number of engines produced with the modification incorporated each year. The cell name version of the formula for CN14 is:

=*IF*(*CurYrEngDel*>0,*TRUNC*(*CurYrEngDel***MoAvailProd*/12),0)

The cell reference version of the formula for CN14 is:

$$=IF(Q14>0,TRUNC(Q14*O14/12),0)$$

Formulas for cells CN15 through CN46 are similar.

This IF statement uses the following logic to determine the number of engines produced with the modification incorporated each year.

a. If the annual engine deliveries in the current year is greater than zero (0), the value placed in the cell is the truncated integer value of the product of expected engine deliveries in the current year and the number of available months for modification incorporation in production during the current year divided by twelve (12).

b. If the annual engine deliveries in the current year is not greater than zero (0), the value placed in the cell is zero (0).

The revised cell name version of the formula for CN14 is:

$$=IF(CurYrEngDel>0,(CurYrEngDel*MoAvailProd/12),0)$$

The revised cell reference version of the formula for CN14 is:

$$=IF(Q14>0,(Q14*O14/12),0)$$

Formulas for cells CN15 through CN46 are revised similarly.

The revised formula deletes truncation and allows for non-integerization in the computation of the number of engines produced with the modification incorporated each year.

17. Column CO

Column CO is **Avg. No. Engines - Unmod Engines**. Formulas in this column calculate the number of unmodified engines remaining in the fleet at the end of each year. The cell name version of the formula for CO14 is:

=*MAX*(*TRUNC*(*CurAvgUnmodEng-ProAvgModEng*),0)

The cell reference version of the formula for CO14 is:

=*MAX*(*TRUNC*(*BC14-CP14*),0)

Formulas for cells CO15 through CO46 are similar.

This MAX (maximize) statement determines the whole number of unmodified engines remaining in the fleet each year by displaying the maximum of the following two values.

a. The truncated integer value of the average number of unmodified engines in the fleet during the current year minus the average number of modified engines in the fleet during the current year.

b. Zero (0).

The revised name version of the formula for CO14 is:

=*MAX*((*CurAvgUnmodEng-ProAvgModEng*),0)

The revised cell reference version of the formula for CO14 is:

=*MAX*((*BC14-CP14*),0)

Formulas for cells CO15 through CO46 are revised similarly.

The revised formula deletes truncation and allows for non-integerization in the computation of the average number of

unmodified engines remaining in the fleet at the end of each year.

18. Column CP

Column CP is **Avg. No. Engines - Mod Engines.** Formulas in this column calculate the expected number of engines that will be modified in the fleet each year. The cell name version of the formula for CP14 is:

=MIN(TRUNC((CurYrEngModProd+CurYrCumKitInstl+PrevYrEngModProd+PreYrCumKitInstl)/2),CurAvgUnmodEng)

The cell reference version of the formula for CP14 is:

=MIN(TRUNC((AB14+AC14+AB13+AC13)/2),BC14)

Formulas for cells CP15 through CP46 are similar.

This MIN (minimize) statement determines the whole number of engines modified in the fleet each year by displaying the minimum of the following two values.

a. The truncated integer value of the sum of the number of engines modified in production during the current year, the cumulative number of engine modification kits installed in the current year, the number of engines modified in production during the previous year, and the cumulative number of engine modification kits installed in the previous year divided by two.

b. The average number of unmodified engines in the current year.

The revised name version of the formula for CP14 is:

=MIN(((CurYrEngModProd+CurYrCumKitInstl+PrevYrEngModProd+PreYrCumKitInstl)/2),CurAvgUnmodEng)

The revised cell reference version of the formula for CP14 is:

=MIN(((AB14+AC14+AB13+AC13)/2),BC14)

Formulas for cells CP15 through CP46 are revised similarly. revised formula deletes truncation and allows for non-integerization in the computation of the average number of engines modified in the fleet each year.

19. Column CU

Column CU is **Sched. Events - Unmod**. Formulas in this column calculate the annual number of scheduled maintenance events for unmodified engines. The cell name version of the formula for CU14 is:

=*IF*(*CurYr2>UnmodSchAvailYr*,*MIN*((*TotEngDel-TotEngModProd-PrevYrCumKitInstl*)*(1+*UnmodInspPerYr*),*TRUNC*(0.5+*CurCalSchMaintInt*ProUnmodSchInspEfh*/1000)),0)

The cell reference version of the formula for CU14 is:

=*IF*(*CM14>AF14*,*MIN*((*Q$48-CN$48-AC13*)*(1+*AG$54*),*TRUNC*(0.5+*E33*AG14*/1000)),0)

Formulas for cells CU15 through CU46 are similar.

This IF statement uses the following logic to determine the annual number of scheduled maintenance events for unmodified engines.

a. If the current calendar year is greater than the year in which scheduled maintenance inspections of

unmodified components are expected to begin under the proposed configuration, the minimum of the following two values is displayed in the cell.

(1) The product of: [total annual engine deliveries minus total engines modified in production minus the cumulative number of kits installed in the previous year] and [1 plus the number of engine inspections per year].

(2) The truncated integer value of 0.5 plus the product of the calculated scheduled maintenance interval rate per 1000 engine flight hours in the current configuration and the total number of engine flight hours per year which are expected to be flown on unmodified engines under the proposed modification schedule divided by 1000.

b. If the current calendar year is not greater than the year in which scheduled maintenance inspections of unmodified components are expected to begin under the proposed configuration, the value displayed in the cell is zero (0).

The revised cell name version of the formula for CU14 is:

```
=IF(CurYr2>UnmodSchAvailYr,MIN((TotEngDel-TotEngModProd-
PrevYrCumKitInstl)*(1+UnmodInspPerYr),(CurCalSchMaintInt*
ProUnmodSchInspEfh/1000)),0)
```

The revised cell reference version of the formula for CU14 is:

```
=IF(CM14>AF14,MIN((Q$48-CN$48-AC13)*(1+AG$54),(E33*AG14/
1000)),0)
```

Formulas for cells CU15 through CU46 are revised similarly.

The revised formula deletes truncation and the addition of 0.5. This revision allows the annual number of scheduled maintenance events for unmodified engines to be calculated as a non-integer value.

20. Cell CU48

Cell CU48 is **Total Sched. Events - Unmod.** The formula in this cell calculates the sum of the annual number of scheduled maintenance events for unmodified engines. The cell name version of the formula for CU48 is:

=*TRUNC*(*SUM*(*CU14*:*CU46*))

The cell reference version of the formula for CU48 is the same as the cell name version. This formula computes the total whole number of annual scheduled maintenance events for unmodified engines.

The revised cell name and cell reference version of the formula for CU48 is:

=(*SUM*(*CU14*:*CU46*))

This revision deletes truncation and allows the value computed for the total of annual scheduled maintenance events for unmodified engines to be a non-integer value.

21. Column CV

Column CV is **Sched. Events - Mod.** Formulas in this column calculate the annual number of scheduled maintenance

events for modified engines. The cell name version of the formula for CV14 is:

=*IF*(*ProAvgModEng*<=0,0,*IF*(*CurYr2*>*ModSchAvailYr*,*IF*(*CurSchMaintInt*=*ProSchMaintInt*,*TRUNC*(*CurSchEventUnmod*-*ProSchEvtUnmod*+0.5),*ProCalSchMaintInt***ProModSchInspEfh*/1000),*IF*(*ProSchEvtUnmod*=0,0,*TRUNC*(*CurSchEvtUnmod*-*ProSchEvtUnmod*+0.5))))

The cell reference version of the formula for CV14 is:

=*IF*(*CP14*<=0,0,*IF*(*CM14*>*AH14*,*IF*(*E32*=*F32*,*TRUNC*(*BI14*-*CU14*+0.5),*F33***AI14*/1000),*IF*(*CU14*=0,0,*TRUNC*(*BI14*-*CU14*+0.5))))

Formulas for cells CV15 through CV46 are similar.

This IF statement uses the following logic to determine the annual number of scheduled maintenance events for modified engines.

a. If the average number of modified engines in the current year is less than or equal to zero (0), the value displayed in the cell is zero (0).

b. If the average number of modified engines in the current year is greater than zero (0), the value displayed in the cell is determined by the following IF statement.

(1) If the current calendar year is greater than the year during which scheduled maintenance inspections of modified components will begin under the proposed configuration,

the value displayed in the cell is determined by the following IF statement.

(a) If the scheduled maintenance interval under the current configuration is equal to the scheduled

maintenance interval under the proposed configuration, the value displayed in the cell is the truncated integer value of the annual number of scheduled engine events for unmodified engines minus the annual number of scheduled engine maintenance events for unmodified engines plus 0.5.

(b) If the scheduled maintenance interval under the current configuration is not equal to the scheduled maintenance interval under the proposed configuration, the value displayed in the cell is the product of the calculated scheduled maintenance interval rate per 1000 engine flight hours and the total number of engine flying hours per year that are expected to be flown on modified engines under the proposed modification schedule divided by 1000.

(2) If the current calendar year is not greater than the year during which scheduled maintenance inspections of modified components will occur under the proposed configuration,
the value displayed in the cell is determined by the following IF statement.

(a) If the annual number of scheduled engine maintenance events for unmodified engines is equal to zero (0), the value displayed in the cell is zero (0).

(b) If the annual number of scheduled engine maintenance events for unmodified engines is not equal to zero (0), the value displayed in the cell is the truncated integer value of the annual number of scheduled engine events

for unmodified engines minus the annual number of scheduled engine maintenance events for unmodified engines plus 0.5.

The revised cell name version of the formula for CV14 is:

=*IF*(*ProAvgModEng*<=0,0,*IF*(*CurYr2*>*ModSchAvailYr*,*IF*(*CurSchMaintInt*=*ProSchMaintInt*,(*CurSchEventUnmod*-*ProSchEvtUnmod*),*ProCalSchMaintInt***ProModSchInspEfh*/1000),*IF*(*ProSchEvtUnmod*=0,0,(*CurSchEvtUnmod*-*ProSchEvtUnmod*))))

The revised cell reference version of the formula for CV14 is:

=*IF*(*CP14*<=0,0,*IF*(*CM14*>*AH14*,*IF*(*E32*=*F32*,(*BI14*-*CU14*),*F33***AI14*/1000),*IF*(*CU14*=0,0,(*BI14*-*CU14*))))

Formulas for cells CV15 through CV46 are revised similarly.

The revised cell formula deletes both truncations and both additions of 0.5. This revision allows the annual number of scheduled maintenance events for modified engines to be calculated as a non-integer value.

22. Cell CV48

Cell CV48 is **Total Sched. Events - Mod**. The formula in this cell calculates the sum of the annual number of scheduled maintenance events for modified engines. The cell name version of the formula for CV48 is:

=*TRUNC*(*SUM*(*CV14*:*CV46*))

The cell reference version of the formula for CV48 is the same as the cell name version.

This formula computes the sum of the whole numbers of annual scheduled maintenance events for modified engines.

The revised cell name and cell reference version of the formula for CV48 is:

=(*SUM*(*CV14*:*CV46*))

This revision deletes truncation and allows the value computed for the total of annual scheduled maintenance events for modified engines to be a non-integer value.

23. Column CX

Column CX is **A/C Loss Events - Annual**. Formulas in this column calculate the number of annual aircraft losses which are expected to occur. The cell name version of the formula for CX14 is:

=*TRUNC*(*CurYrProACLEvtCum*)

The cell reference version of the formula for CX14 is:

=*TRUNC*(*CW14*)

Formulas for cells CX15 through CX46 are similar.

The formula in this cell truncates and integerizes the current year cumulative number of annual aircraft losses which are expected to occur under the proposed configuration.

The revised cell name version of the formula for CX14 is:

=(*CurYrProACLEvtCum*)

The revised cell reference version of the formula for CX14 is:

$$=(CW14)$$

Formulas for cells CX15 through CX46 are revised similarly.

This revision deletes truncation and allows for the calculated value of the number of annual aircraft losses which are expected to occur to be a non-integer value.

24. Column DB

Column DB is **Spare Kits - No. Installed**. Formulas in this column calculate the number of modification kits installed in spare engines each year. The cell name version of the formula for DB14 is:

=*TRUNC*(*SparePartFactor**(*CurYrProEngKitInstal*+*ProEngModProd*))

The cell reference version of the formula for DB14 is:

=*TRUNC*(*D22**(*CY14*+*CN14*))

Formulas for cells DB 15 through DB46 are similar.

This formula determines the number of modification kits installed on spare engines each year by multiplying the spare parts factor by the sum of the number of engine kits installed in the current year and the number of engines modified in production in the current year.

The revised cell name version of the formula for DB14 is:

=(*SparePartFactor**(*CurYrProEngKitInstal*+*ProEngModProd*))

The revised cell reference version of the formula for DB14 is:

$$=(D22*(CY14+CN14))$$

Formulas for cells DB15 through DB46 are revised similarly.

This formula revision deletes truncation and allows the number of modification kits installed in spare engines each year to be calculated as a non-integer value.

D. NON-SUBSTANTIVE REVISIONS

The non-substantive changes to the revised CEAMOD are presented below. Many of these changes were necessitated by the substantive revisions addressed above. Unlike the substantive changes, however, the non-substantive revisions are of a simple straightforward nature designed only to improve readability and provide uniformity of format throughout the model. They have no effect on the numerical calculations of the model.

There were six instances where the non-substantive changes involved the re-wording of column headings. All other revisions involved a change in the number display format. EXCEL 4.0 software allows a user to specify the format that he wishes numerical values be displayed in. The available formats can display values as integers or with any number of decimal places which the user may desire; the software simply employs a standard 0.5 rounding rule when rounding the display to the number of decimal places the user has chosen. Most importantly, the actual value remaining in the cell is

unchanged regardless of the number of decimal places shown by the display format. To provide a "feel" for the values in the non-integerized revision to CEAMOD 2.0 which are fractional, the author changed numerous display formats from "general" format to a format displaying two decimal places. (There are several instances noted and explained in the tables which follow where other than two decimal places was used.) The "general" display format would have allowed EXCEL 4.0 to use whatever display format it thought appropriate.

For simplicity, non-substantive revisions were grouped by type of change and placed in tables containing brief explanations of each type of change. Table I lists the non-substantive changes made to columns and cells which also had substantive changes made in them.

TABLE I: NON-SUBSTANTIVE CHANGES MADE TO COLUMNS/CELLS ALSO RECEIVING SUBSTANTIVE CHANGES

Column(s)/ Cell(s)	Nature of Non-Substantive Change(s)
Columns S, Y, Z, AA, AM, AP, AR, AW, BC, BI, CN, CO, CP, CU, CV and DB	Number display format changed from general to two (2) decimal places.
Cell W12	This cell is a column heading. The word "Whole" was deleted to reflect the fact that formulas in this column were revised to compute non-integer (rather than whole number) values.
Cells AG53 and AG54	Number display format was changed from general to six (6) decimal places. Six (6) is an arbitrary choice made simply to fill the width of the cell and reflect the non-integerized nature of the formulas in these cells. Cell alignment was also changed from center to right.
Cells AM12, AP12, AR12 and AW12	These cells are columnar headings. The word "Integer" was changed to "Decimal" to reflect the fact that formulas in these columns were changed to compute non-integer values.
Column CX	Number display format changed from general to one (1) decimal place. This column is one of two under the heading "A/C Loss Events." The first (column CW) was originally written to display a single decimal place, so column CX was changed to do the same.

Additional columns and cells (other than those where substantive changes mere made) received non-substantive changes. Table II reflects these changes.

TABLE II: NON-SUBSTANTIVE CHANGES MADE TO COLUMNS/CELLS NOT RECEIVING SUBSTANTIVE CHANGES

Column(s)/ Cell(s)	Nature of Non-Substantive Change(s)
Columns R, W, AB, AC, AD, AE, AG, AI, AS, AX, AY, BG, CS, CT and CY	Number display format changed from general to two (2) decimal places.
Columns AF and AH	These columns display years. The number display format was changed from general to whole number to ensure the values displayed for years are not fractional (e.g., 1993 vice 1993.4). EXCEL uses a standard 0.5 rounding rule when rounding to whole numbers. This change was necessitated because formulas in column AF key off of the value in cell AG53 which was non-integerized.
Cell AS12	This cell is a column heading. The word "Integer" was changed to "Decimal" to reflect the fact that formulas in this column were changed to compute non-integer values.
Cell CR49	Number display format changed from general to three (3) decimal places. The formula in cell CR49 adds the totals of columns CQ and CR (cells CR14 through CR46). These two columns were originally written to display three (3) decimal places, so cell CR49 was changed to do the same.

E. REVISION SUMMARY

This chapter described the development of a non-integerized revision to CEAMOD Version 2.0. Two types of changes were presented. Substantive changes were made to provide non-integer expected values, and each of these substantive changes had a resulting impact on the numerical calculations of the model. Detailed explanations of each formula receiving a substantive change were provided. Non-

substantive changes were made only to serve purposes of consistency and readability throughout the model. These simple changes were of a straightforward nature, and the explanations of the changes were grouped into brief tables for presentation and documentation.

IV. SENSITIVITY ANALYSIS OF THE NON-INTEGERIZED MODEL

A. INTRODUCTION

Chapter III provided a description of the non-integerized version of the CEAMOD. This chapter provides an analysis which compares that version with Version 2.0 of the CEAMOD. The comparison was made using the example provided by General Electric [Ref. 5] for model discussion purposes at CEA Users' Group meetings. This is the same example which provided the data base used by Clague [Ref. 3] and Crowder [Ref. 6] in their thesis research. However, Clague and Crowder used CEAMOD Version 1.3, written in LOTUS 123 software. As a result of minor changes through the version updates, the example data base yields slightly different results than Version 1.3 when run through the CEAMOD Version 2.0, written in EXCEL 4.0, which forms the basis for this thesis.

Appendix A contains a complete CEAMOD Version 2.0 Analysis Package printout for the example database. Appendix B contains a complete CEAMOD Analysis Package printout of the example database processed through the revised non-integerized version of the model described in this thesis. Both printouts in appendices A and B include the additional three pages described at the end of Chapter II.

B. CEAMOD ANALYSIS PACKAGE

A brief "walk-through" of the contents of the example CEAMOD Analysis Package is presented in this section. This expands the format description provided at the end of Chapter II and serves to highlight selected differences observed in the analysis packages provided by CEAMOD Version 2.0 (Appendix A) and the non-integerized revision to the model (Appendix B). Each page is discussed below in the order in which the packages are put together in the appendices. This order represents that in which CEAMOD Analysis Packages are normally assembled. However, this order is not the same as seen when viewing the "pages" on a personal computer. That order was described at the end of Chapter II.

1. Summary Page

The Summary Page provides a cost summary in thousands of dollars of the "delta" cost differences between the current and proposed configurations. Nine categories of cost analysis are listed, with dollar values shown under "Cost" indicating increased costs or under "Savings" indicating decreased costs. Costs and Savings figures are "netted" together to get the Net Delta Dollar Impact value. This value is essentially the "bottom line" result of the Engineering Change Proposal (ECP) analysis conducted by CEAMOD. The non-integerized revision to CEAMOD Version 2.0 calculated a Net Delta Dollar Impact value

of \$6,809K. This is \$15K higher than the \$6,794K figure produced by the unmodified Version 2.0.

2. Input Page

Following the Summary Page is a page where the manufacturer enters input data needed to run the model. This page contains Task Incorporation Input and Standard Inputs, both of which are common to the current and proposed engine configurations. Other categories of inputs include Scheduled Input, Unscheduled Input and Optional Input. These last three sets of inputs serve to contrast the differences between the current and proposed configurations. This input page is identical for the two analysis packages provided in Appendices A and B.

3. Calculated Costs/Event Page

The next page is titled Calculated Costs/Event. As its name implies, this page displays the costs per event which have been calculated by CEAMOD's Interim Calculations Page (discussed in Subsection 4. below). This page is identical for the two analysis packages provided in Appendices A and B.

4. Interim Calculations Page

The Interim Calculations Page follows the Calculated Costs/Event Page. This page provides an easy-to-read format for comparison of current and proposed configuration costs. Additionally, the Interim Calculations Page provides an ECP proposal evaluator with a fairly simple set of equations which

describe how the costs displayed were determined. The Operational Events & EFH section contains the only differences on this page between the two analysis packages provided in Appendices A and B. The page from Appendix B has different values and additional decimal places in the first two rows as a result of the non-integerization applied to CEAMOD Version 2.0. The most significant differences are in the scheduled events row; 2932 versus 2862 for the current configuration and 813 versus 743 for the proposed unmodified configuration. Interestingly, the proposed modified configuration values are identical.

5. Standard History File - 1st Page (page 2)

Following the Interim Calculations Page comes the first of three pages of the Standard History File (columns N through W). This "file" displays the annual expected value calculations for a wide range of categories. Among the information presented on the first page is the number of available modification months (months when modifications can be made because kits are available), the number of engine deliveries, the number of anticipated engine flight hours and expected engine attrition data. The analysis package from Appendix B exhibits different, non-integerized values in columns S and W, reflecting the non-integerization applied in the revision to CEAMOD Version 2.0. Comparison of the two W columns shows a puzzling dip from three (3) to two (2) in

engine attrition for Version 2.0 in the year 2003 while the non-integerized version shows nothing comparable. Also of note is the increase by 311.11 (2,986,800 to 2,987,111.11) in total annual engine flight hours in the fleet shown at the bottom of column S. However, this difference is spread over many years.

6. Standard History File - 2nd Page

The second page of the Standard History File includes columns Y through AD and contains data on the number of engines upgraded via each incorporation style as well as data on engine modification change kits. Appendix B's printout from the revision to CEAMOD Version 2.0 displays two decimal places in every column on this page. The only column which differs to any significant extent is column AD. From year 2002 on the column elements differ by approximately 75 cumulative engine flight hours.

7. Standard History File - 3rd Page

The third and final page of the Standard History File (columns AE through AY) contains an extensive amount of data, particularly with regard to the number of events occurring due to unscheduled engine failures. Decimal places have been added to almost all columns in the revision to CEAMOD Version 2.0. The analysis package from Appendix B shows this and also displays two notable changes to the calculated values for years/inspection interval and inspections/year found in the

lower left hand corner of the page. Version 2.0 shows a value of 3 while the non-integer version shows a value of 3.958 for the number of years between inspections. Another significant difference is in the total number of years of (modification) incorporation presented at the bottom of column AT. This value is 12 in the Appendix A printout and 13 in the Appendix B printout. Finally, the Version 2.0 printout shows in column AG a value of 68880 engine flight hours in 1988 (the fifth year) whereas the non-integerized model shows a zero (0).

8. Current Configuration - 1st Page (page 3a)

Two pages of data on the current configuration follow the Standard History File. The first page displays data relative to the number of unmodified engines in the fleet, engine flight hours, unscheduled events and scheduled events. The printout in Appendix B displays decimal places in the columns, and also reflects a reduction of 69.96 (2932-2862.04) in the total number of scheduled events on unmodified engines shown at the bottom of column BI. The puzzling dip mentioned above for the first page of the Standard History File of Version 2.0 for the W column is seen again in the BG column. The non-integerized version has no such dip. Finally, column BI shows a 69 in year five of the Version 2.0 printout and a zero (0) for the non-integerized version.

9. Current Configuration - 2nd Page (page 3b)

The second page of current configuration data essentially takes the data form the first page and "prices it out" to determine costs. Comparing the pages from the two analysis packages provided in Appendices A and B, it can be seen that column totals are different in every instance except for column BW. The entries in columns BZ strongly illustrate the effect of non-integerization.

10. Proposed Configuration - 1st Page (page 4a)

Two pages on the proposed configuration are next. The first page displays an extensive amount of data relative to maintaining and supporting the fleet of engines as new ECP components are installed and the proposed configuration evolves. The printout in Appendix B displays decimal places in the columns, and also yields different column totals from those seen in Appendix A. The most notable difference is that the total number of scheduled events displayed by the Appendix B printout at the bottom of column CV is reduced by 69.6 (2402-2332.40). The CU column shows a 69 in the fifth year for Version 2.0 and a zero (0) for the non-integerized version. The column CU totals are also different by 69.5.

11. Proposed Configuration - 2nd Page (page 4b)

The second page of proposed configuration data is similar to the second page of current configuration data in that its purpose is primarily to "price out" data from the

first page. Comparing the pages from the two analysis packages provided in Appendices A and B, it can be seen that many of the column totals are different. Of particular interest are the columns DL and DP. Version 2.0 shows zeros when the non-integerized version shows non-zero entries.

12. Comparison of Current and Proposed Expenditures (Costs) - (page 5)

The last page of the CEAMOD Analysis Package is untitled. It displays a comparison of the expected expenditures associated with maintaining the fleet under the current and proposed configurations. This page also contains delta cashflow and net present value (NPV) data. As expected, the data in the Appendix B printout is different due to the non-integerization applied to CEAMOD Version 2.0.

C. COMMENTS ON NON-INTEGERIZATION

The CEAMOD is a complex life cycle costing model. As can be seen from the formulas presented in Chapter III, the value shown in a given cell is often calculated using a formula which "keys" off of the values in many other cells. As non-integerization was applied to the value computed in a single cell, this procedure had a "ripple" effect on all the other cells in the model (including those which the author did not revise) whose calculations "key" off of the non-integerized cell. Since non-integerization of the model involved hundreds

of cells, the "ripple" effects crisscrossing throughout the model are massive.

Attempting to isolate the one non-integerization change which was the major cause in Net Delta Dollar Impact value differences between the unmodified and non-integerized versions of CEAMOD is difficult. Two non-integerization changes, however, appear to drive most all others.

Non-integerization of years/inspection interval (cell AG53) changes the value in this cell from 3 to 3.958333. This revision, in turn, changes the first year in which scheduled maintenance inspections of unmodified components are expected to occur under the proposed configuration (cell AF14) from 1987 to 1988. It also changes the first year in which scheduled maintenance inspections of modified components are expected to occur under the proposed configuration (cell AH14) from 1987 to 1988.

The second change of consequence is reflected in cell AT48. This cell calculates the value of the total number of years of (engine modification) incorporation by using the formula:

=*SUM*(*AT14*:*AT46*)

The cell name and cell reference version of this formula are the same. Since this formula does nothing more than add the values calculated in cells AT14 through AT46, it is necessary

to look at the formulas in these cells. The cell name version of the formula for AT14 is:

$$=IF(CurYrProEngKitInstal=0,0,1)$$

The cell reference version of the formula for AT14 is:

$$=IF(CY14=0,0,1)$$

Formulas for cells AT15 through AT46 are similar.

This IF statement uses the following binary type logic to place either a zero (0) or a one (1) in the cell.

a. If the number of engine modification kits installed under the proposed configuration during the current year is equal to zero (0), the value placed in the cell is zero (0).

b. If the number of engine modification kits installed under the proposed configuration during the current year is not equal to zero (0), the value placed in the cell is one (1).

The ones (1's) calculated and placed in cells AT14 through AT46 simply indicate that engine modification kits were installed during a specific year. Cell AT48 totals the ones (1's) to determine the total number of years in which engine modification incorporations occur. As shown above, the formulas in cells AT14 through AT46 key off of the values for the annual number of engine kits installed which is calculated in column CY. Comparison of column CY values in the two printouts in Appendices A and B reveals that these values have

changed in the second printout due to the non-integerization applied in the revision to CEAMOD Version 2.0. (Formulas in column CY were not revised, but they key off of many others which were.) Notably, the 0.81 engine kits installed shown in cell CY32 translates into a one (1) in cell AT32. This is a one (1) which was not present prior to non-integerization of the model. The end result is that the total value reflected in cell AT48 becomes 13 rather than the 12 shown in the printout from the unmodified CEAMOD Version 2.0. The delay in the installation of kits (spread out over 13 years rather than 12) delays the maintenance cost improvements expected so the net present value will be higher for the non-integerized version.

The two changes addressed above appear to be the most influential because they involve the specific years in which events occur and the total number of years in which events occur. Changes with regard to these two factors apparently have the most effect in Net Delta Dollar Impact value differences between the unmodified and non-integerized versions of CEAMOD.

D. DETERMINATION OF COST DRIVERS

Individual elements which dominate the cost determinations in a life cycle costing model such as CEAMOD are termed cost drivers. When varied in magnitude, these cost drivers exert

the largest percentage changes on the total life cycle cost of the ECP under consideration.

Extensive analysis by Crowder concluded that Incorporation Style, Kit Hardware Cost - $/Engine, and the Spare Parts Factor were the major cost drivers in Version 1.3 of CEAMOD. [Ref. 6:p. 22] Crowder's procedure involved doubling 22 principal input elements, one at a time, to analyze the effect this variation had on the computed life cycle cost of the example ECP. His determination of the model's cost drivers other than Incorporation Style was based on the percentage change in the proposed configuration's total expected life cycle costs (shown in cell DS48) computed using the doubled parameter input value as compared to the proposed configuration's total expected life cycle costs calculated with the base parameter input value.

Crowder's procedure was repeated on CEAMOD Version 2.0 to determine if the same three data input elements - Incorporation Style, Kit Hardware Cost - $/Engine, and the Spare Parts Factor - remained the major cost drivers following the updates/changes in the model between Versions 1.3 and 2.0. These same three data elements were indeed found to still be the model's primary cost drivers. Appendix C summarizes the results of this finding.

A review of Appendix C shows that Incorporation Style 3 (indicated in cell D9) yielded total expected life cycle costs for the proposed configuration of $28,471,000 (cell DS48).

These costs are $5,933,000 (28,471,000-22,538,000) or 26.32% higher than the costs using the base Incorporation Style of 2. A Kit Hardware Cost - $/Engine value of $30,000 (cell D16) yielded total expected life cycle costs for the proposed configuration of $31,193,000. These costs are $8,655,000 (31,193,000-22,538,000) or 38.4% higher than the costs using the base Kit Hardware Cost - $/Engine value of $15,000. Lastly, a Spare Parts Factor of 100% (cell D22) yielded total expected life cycle costs for the proposed configuration of $32,255,000. These costs are $9,717,000 (32,255,000-22,538,000) or 43.11% higher than the costs using the base Spare Parts Factor of 0%. These three percentage changes (shown in boldface type in the table in Appendix C) were the largest achieved in this cost driver analysis.

A second repetition of Crowder's procedure was performed on the non-integerized version of CEAMOD to verify that the same three data input elements were also the leading cost drivers in the revised model. The analysis confirmed that they were. Appendix D summarizes the results of this finding.

A review of Appendix D shows that Incorporation Style 3 (indicated in cell D9) yielded total expected life cycle costs for the proposed configuration of $27,973,000 (cell DS48). These costs are $5,939,000 (27,973,000-22,034,000) or 26.95% higher than the costs using the base Incorporation Style of 2. A Kit Hardware Cost - $/Engine value of $30,000 (cell D16) yielded total expected life cycle costs for the proposed

configuration of $30,685,000. These costs are $8,651,000 (30,685,000-22,034,000) or 39.26% higher than the costs using the base Kit Hardware Cost - $/Engine value of $15,000. Lastly, a Spare Parts Factor of 100% (cell D22) yielded total expected life cycle costs for the proposed configuration of $31,752,000. These costs are $9,718,000 (31,752,000-22,034,000) or 44.10% higher than the costs using the base Spare Parts Factor of 0%. These three percentage changes (shown in boldface type in the table in Appendix D) were the largest achieved in this cost driver analysis.

Comparing Appendices C and D, it can be noted that the same three data input elements were determined to be the major cost drivers in both CEAMOD Version 2.0 and the non-integerized revision to the model. Further, the dollar value and percentage differences achieved by varying these three data elements was nearly identical between the current CEAMOD Version 2.0 model and the revision.

E. COST DRIVER SENSITIVITY ANALYSIS AND MODEL COMPARISON

Having determined that Incorporation Style, Kit Hardware Cost - $/Engine, and the Spare Parts Factor were the major cost drivers of both CEAMOD Version 2.0 and the non-integerized revision to the model, the next step was to vary these three elements through a range of values and compare the results obtained from the current and revised versions of the model.

A decision-maker reviewing a CEAMOD Analysis Package is primarily concerned with the Net Delta Dollar Impact value of the ECP shown on the printout's Summary Page. On a computer monitor, this value is shown in either cell EI45 (cost) or in cell EL45 (savings). In the analyses which follow, the percentage change in the Net Delta Dollar Impact values between the two models was used as the main vehicle for comparison.

1. Incorporation Style

The incorporation style value in cell D9 was varied through all three modes - 1 (attrition), 2 (retrofit at 1st opportunity) and 3 (forced retrofit). In mode 3, the number of kits used in the forced retrofit per month (cell D12) was varied from one (1) to nine (9). Table III provides the results of this sensitivity analysis performed by varying incorporation style.

As the table shows, very little percentage difference was found in the values of the total expected life cycle cost delta obtained from the unmodified and revised versions of CEAMOD. The largest difference, which was still a relatively small -3.01%, was achieved with incorporation style 3 with 3 kits/month used in the forced retrofit. All Net Delta Dollar Impact values shown are positive indicating that the expected total life cycle costs savings from acceptance and implementation of an Engineering Change Proposal (ECP)

outweigh the expected total life cycle costs. The fact that 3.01% is a negative figure indicates that the revised model yields 3.01% less costs savings than that achieved from CEAMOD Version 2.0.

TABLE III: INCORPORATION STYLE SENSITIVITY ANALYSIS

Incorporation Style (Cell D9)	Kits/Month (Cell D12)	Net Delta Dollar Impact (000's) (Cells EI45, EL45)		Difference Non-Integerized CEAMOD value – CEAMOD value (000's)	% Change (Difference/ CEAMOD value)
		CEAMOD	Revised Non-Integerized CEAMOD		
1	N/A	$6,794	$6,809	$15	0.22%
2 (Base Value)	N/A	$6,794	$6,809	$15	0.22%
3	1	$1,360	$1,358	($2)	−0.15%
	3	$2,292	$2,223	($69)	−3.01%
	5	$4,678	$4,584	($94)	−2.01%
	7	$5,996	$5,963	($33)	−0.55%
	9	$6,817	$6,780	($37)	−0.54%

2. Kit Hardware Cost - $/Engine

The kit hardware cost per engine value in cell D16 was varied through a range from $1,000 to $70,000. Table IV provides the results of this sensitivity analysis.

Only very small percentage differences were encountered in the total expected life cycle cost delta values obtained from the unmodified and revised versions of CEAMOD. The largest difference calculated was a relatively small 1.02%, achieved with a kit hardware cost per engine value of $30,000. This number indicates that the revised model yields a Net Delta Dollar Impact value which is 1.02% lower than that

achieved from CEAMOD Version 2.0. It must be noted, however, that the table shows kit hardware cost per engine values of $30,000 and above yield only negative Net Delta Dollar Impact values. In these instances, the expected total life cycle costs from acceptance and implementation of an Engineering Change Proposal (ECP) outweigh the expected total life cycle costs savings. Thus, the 1.02% means that the expected total life cycle costs calculated by the revised model are 1.02% less than those calculated by CEAMOD Version 2.0.

TABLE IV: KIT HARDWARE COST - $/ENGINE SENSITIVITY ANALYSIS

Kit Hardware Cost - $/Engine (Cell D16)	Net Delta Dollar Impact (000's) (Cells EI45, EL45)		Difference Non-Integerized CEAMOD value - CEAMOD value (000's)	% Change (Difference/ CEAMOD value)
	CEAMOD	Revised Non-Integerized CEAMOD		
$1,000	$14,872	$14,882	$10	0.07%
$15,000	$6,794	$6,809	$15	0.22%
$30,000	($1,861)	($1,842)	$19	1.02%
$45,000	($10,516)	($10,492)	$24	0.23%
$60,000	($19,171)	($19,142)	$29	0.15%
$70,000	($27,826)	($27,793)	$33	0.12%

3. Spare Parts Factor

The Spare Parts Factor in cell D22 was varied through a range from 0% to 100%. Table V provides the results of this sensitivity analysis.

Although still relatively small, the largest percentage differences encountered in the total expected life

cycle cost delta values obtained from the unmodified and revised versions of CEAMOD were achieved by varying this input parameter. The largest difference, a negative 3.65%, was achieved with a spare parts factor of 80%. Interpretation of the results of this table is similar to that explained above for Table IV. Negative values in the Net Delta Dollar Impact columns indicate that the expected total life cycle costs from acceptance and implementation of an Engineering Change Proposal (ECP) outweigh the expected total life cycle costs savings. Negative values in the percentage change column of the table indicate that the Net Delta Dollar Impact values obtained from the revised model moved in a negative direction (i.e., reduced savings or increased costs) from those calculated by CEAMOD Version 2.0. The negative 3.65% value mentioned above indicates that the revised model yielded expected total life cycle costs of implementing an ECP which were 3.65% greater than the costs calculated by CEAMOD Version 2.0.

TABLE V: SPARE PARTS FACTOR SENSITIVITY ANALYSIS

Spare Parts Factor (Cell D22)	Net Delta Dollar Impact (000's) (Cells EI45, EL45) CEAMOD	Revised Non-Integerized CEAMOD	Difference Non-Integerized CEAMOD value - CEAMOD value (000's)	% Change (Difference/ CEAMOD value)
0%	$6,794	$6,809	$15	0.22%
20%	$4,930	$4,865	($65)	-1.32%
40%	$2,987	$2,921	($66)	-2.21%
60%	$1,011	$978	($33)	-3.26%
80%	($932)	($966)	($34)	-3.65%
100%	($2,924)	($2,909)	$15	0.51%

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

A. SUMMARY

The main objective of this thesis was to examine the effect that non-integerizing formulas, data fields and parameter inputs would have on the CEAMOD Version 2.0. The author sought to determine if a non-integerized version of CEAMOD could ultimately lead to different decisions than those made by using the current model.

To accomplish this objective, the author had to first familiarize himself with the multitude of formulas contained in the model and the assumptions behind those formulas. That required a thorough review of previous research work, model documentation and the computer model itself. This was presented in Chapter II. Following this, non-integerization of CEAMOD was accomplished as discussed and documented in Chapter III.

Chapter IV presents the results of a comparison of the two models (including sensitivity analyses) using an example data set. Part of this comparison was to determine the cost drivers of the current CEAMOD Version 2.0, written in EXCEL 4.0. Following the procedure employed by Crowder [Ref. 6], 22 different runs of the model were made. In each of the runs a single parameter input was isolated and varied to determine

its impact on total proposed costs of the Engineering Change Proposal (ECP) under consideration. The procedure was then repeated on the non-integerized version of CEAMOD described in Chapter III. This effort determined that both the current and revised models' principal cost drivers were the same three as those identified by Crowder. Finally, 38 iterations of the current model and its non-integerized version were run to conduct sensitivity analysis of the major cost drivers and to compare the Net Delta Dollar Impact values obtained from the two models.

B. CONCLUSION

It is important to first mention that the revised version of the model yield the theoretically correct expected values of the life cycle costs associated with implementation of an ECP. A major aspect of the non-integerized version of CEAMOD was the elimination of arbitrary rounding and truncating in the calculation of values which would have otherwise been fractional by virtue of the probabilistic nature of engine component failures.

Under no circumstances did the results achieved using the non-integerized model lead to different decisions than those reached through using the current model. The sensitivity analyses showed that the differences in Net Delta Dollar Impact values obtained from the two models were very small. The largest percentage difference occurred with utilization of

a spare parts factor of 80% in cell D22. The 3.65 percent difference obtained here was equal to only $34,000, an almost insignificant sum when compared to the total cost and scope of aircraft engine component improvement programs. A larger dollar value difference of $94,000 was shown in Table III when Incorporation Style 3 (forced retrofit) with five (5) kits per month was analyzed. This dollar figure, too, is deemed insignificant.

The process of eliminating truncation and rounding did, however, lead to discovery of instances throughout the model where formulas were may have been incorrectly converted from LOTUS 123 to EXCEL. These instances have been transmitted to the CEA Users' Group for evaluation.

C. RECOMMENDATIONS

The test research conducted incident to this thesis revealed no occasion when the revised version of the model led to different decisions. Therefore, CEAMOD Version 2.0 should continue to be used in Evaluating Engineering Change Proposals. However, because results obtained using the revised model are theoretically correct from the point of view of expected value determination, it may be useful to a user desiring the associated increased accuracy and precision. Therefore, a floppy disk copy of the non-integerized revision to CEAMOD Version 2.0 may be obtained from Professor Alan McMasters of the Naval Postgraduate School.

APPENDIX A

CEAMOD ANALYSIS PACKAGE PRINTOUT

Appendix A is an example of an Engineering Change Proposal (ECP) CEAMOD Version 2.0 Cost Effectiveness Analysis Package printout based on a test data base provided by General Electric. Three additional pages described at the end of Chapter II are included.

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA
TASK/ECP: Task 000

F-16

CEA VERSION 2.0 11/19/93
CEA Guru

Sample text which appears on page 5. Line 1
Sample line 2
Sample line 3
Sample line 4
Sample line 5
Sample line 6
Sample line 7
Sample line 8
Sample line 9
Last Line Saved. Line 10

SUMMARY - Delta between current and proposed configurations.
All values shown are THOUSANDS of fiscal year 1991 dollars.

		Cost	Savings
1)	Production Engine Cost	$330 K	
2)	Operational Engine Modification Cost	$9,192 K	
3)	Follow-on Maintenance Material Cost		$15,449 K
4)	Follow-on Maintenance Labor Cost		$888 K
5)	Publications Cost	$2 K	
6)	Support Equipment Cost	$1 K	
7)	Part Number Cost	$18 K	
8)	Operational Fuel Cost		
9)	Aircraft Loss Cost		
	Totals	$9,543 K	$16,337 K

Net Delta Dollar Impact	$6,794 K

Net Present Value at	10%	($1,055)K

ASSUMPTIONS

a)	Incorporation in Production engines will begin in		May	1991
b)	Number of engines produced with this change is			33
c)	Number of spare units incorporating this change is			0
d)	Modification of operational engines can begin in		Aug	1991
e)	Incorporation of this change in operational engines will be accomplished by --->	1st Opportunity	at	Depot
f)	Total kits installed out of total engines not modified in production is	577	of	617
g)	Total engines lost to attrition is			59
h)	Total engines retired unmodified is			0
i)	Estimated yearly flying hours	240		EFH / Year

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA
TASK/ECP: Task 000

F-16

CEA VERSION 2.0 11/19/93
Pg. 1

Task Incorporation Input

1.0	Incorporation Style: (1,2 or 3) 1 = Attrition 2 = Retrofit at 1st Opportunity 3 = Forced Retrofit — Kits / Month ⟶	2 0
2.0	Does Kit Cost Replace Normal Maint. Material Cost? 1=Yes 0=No	0
3.0	Delta Production Cost	$10,000
4.0	Kit Hardware Cost - $ / Engine	$15,000
5.0	Kit Labor Manhours at O&I	2
6.0	Kit Labor Manhours at Depot	20
7.0	Technical Pubs Cost - Total $	$500
8.0	TCTO Cost - Total $	$1,500
9.0	Tooling/Support Equipment Cost-Total $	$500
10.0	Spare Parts Factor	0%
11.0	Scheduled % Events being Modified	100%
12.0	Unscheduled % Events being Modified	100%
13.0	Unscheduled Event Rate allowing Modification	0.020
14.0	Production Incorporation Date — Year ⟶	1991	Month ⟶ 5
15.0	Field Incorporation Date — Year ⟶	1991	Month ⟶ 8

Standard Inputs	
Fiscal Year Dollars	1991
NPV Rate	10%
Labor Cost / Manhour at O&I	$32.32
Labor Cost / Manhour at Depot	$43.30
Cost to introduce new P/N - $ / PN	$1,524
Cost to Maintain each P/N / Year	$250
Fuel Cost / Gallon	$0.61
Test Fuel - Gallons / Hour	150
Flight Fuel - Gallons / Hour	150
EFH / Year	240
TAC / EFH Ratio	3.00
TOT / EFH Ratio	1.50
Aircraft Cost	$0

		CURRENT	PROPOSED
	Scheduled Input		
16.0	Scheduled Maintenance Interval (TAC's)	3000	4000
17.0	Calculated Scheduled Maintenance Interval Rate/1000 EFH	1.000	0.750
18.0	Scheduled Manhours to Inspect at O level	0.0	0.0
19.0	Scheduled % Removed at O&I level	100%	100%
20.0	Scheduled Manhours to Remove/Replace at O level	10.0	10.0
21.0	Scheduled Manhours at I level	25.0	25.0
22.0	Scheduled % at O&I requiring Repair	100%	100%
23.0	Scheduled Repair Cost at O&I level	$500	$500
24.0	Scheduled % Returned to Depot	100%	100%
25.0	Scheduled Manhours at Depot	10.0	10.0
26.0	Scheduled % at Depot requiring Repair	10%	1%
27.0	Scheduled Repair Cost at Depot	$25,000	$20,000
28.0	Scheduled % Scrapped	5%	1%
29.0	Hardware Cost to Scrap	$62,500	$50,000
30.0	Scheduled Engine Test Time	1.50	1.50
	Unscheduled Input		
31.0	Unscheduled Event Rate/1000 EFH	0.020	0.002
32.0	Unscheduled Manhours at O level	0.0	0.0
33.0	Unscheduled % Removed at O&I level	100%	100%
34.0	Unscheduled Manhours to Remove/Replace at O level	10.0	10.0
35.0	Unscheduled Manhours at I level	25.0	25.0
36.0	Unscheduled % at O&I requiring Repair	100%	100%
37.0	Unscheduled Repair cost at O&I level	$500	$500
38.0	Unscheduled % Returned to Depot	100%	100%
39.0	Unscheduled Manhours at Depot	10.0	10.0
40.0	Unscheduled % at Depot requiring Repair	3%	0%
41.0	Unscheduled Repair Cost at Depot	$1,250	$1,000
42.0	Unscheduled % Scrapped	1%	0%
43.0	Hardware Cost to Scrap	$62,500	$5,000
44.0	Unscheduled Engine Test Time	1.50	1.50
45.0	Unscheduled Secondary Damage Costs	$100,000	$100,000
46.0	Unscheduled Incidental Costs	$0	$0
47.0	Number of P/N's	4	4
	Optional Input		
48.0	% Improvement in Specific Fuel Consumption from Current to Proposed		0%
49.0	Aircraft Loss Rate Improvement / 1,000,000 EFH		0.00

CEA Guru

Calculated Costs / Event

Kit Cost	$15,000.00
Labor Cost to Install the Kit	$930.64
Total Cost to Install the Kit	$15,930.64

Scheduled	Current	Proposed
O & I Labor Cost / Scheduled Event	$1,131.20	$1,131.20
Depot Labor Cost / Scheduled Event	$433.00	$433.00
Total Labor Cost / Scheduled Event	$1,564.20	$1,564.20
O & I Repair Cost / Scheduled Event	$500.00	$500.00
Depot Repair Cost / Scheduled Event	$2,500.00	$200.00
Scrap Cost / Scheduled Event	$3,125.00	$250.00
Total Material Cost / Scheduled Event	$6,125.00	$950.00
Test Labor & Fuel Cost / Scheduled Event	$234.21	$234.21
Total Material Incl Test Cost / Scheduled Event	$6,359.21	$1,184.21

Unscheduled	Current	Proposed
O & I Labor Cost / Unscheduled Event	$1,131.20	$1,131.20
Depot Labor Cost / Unscheduled Event	$433.00	$433.00
Total Labor Cost / Unscheduled Event	$1,564.20	$1,564.20
O & I Repair Cost / Unscheduled Event	$500.00	$500.00
Depot Repair Cost / Unscheduled Event	$31.25	$2.50
Scrap Cost / Unscheduled Event	$625.00	$5.00
Total Material Cost / Unscheduled Event	$1,156.25	$507.50
Test Labor & Fuel Cost / Unscheduled Event	$234.21	$234.21
Total Material Incl Test Cost / Unscheduled Event	$1,390.46	$741.71
Second Dam & Inced Cost / Unscheduled Event	$100,000.00	$100,000.00
GrandTotal Material Cost / Unscheduled Event	$101,390.46	$100,741.71
Cost to Introduce the New Part Numbers	N/A	$6,096.00

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

Interim Calculations

CEA VERSION 2.0 11/19/93

(A)	Delta Production Cost	$10,000.00	(D)	Publications Cost	$2,000.00
(B)	Kit Cost	$15,000.00	(E)	Support Equipment	$500.00
(C)	Labor Cost to Install the Kit	$930.64	(F)	Aircraft Cost	$0.00

	Modification Events	*Unscheduled*	*Scheduled*	*Spares*	*Total*
(G)	Engines Modified in Production				33
(H)	Retrofit Events	11.25	565.5833333	0	577

			Proposed	
	Operational Events & EFH	*Current*	*Unmod*	*Mod*
(J)	Scheduled Events	2932	813	1589
(K)	Unscheduled Events	59	17	4
(L)	Engine Flight Hours (In Thousands)	2,986.800	862.560	2,124.240
(M)	Aircraft Losses Delta	N/A	N/A	0

			Proposed		*Equations to Calculate Cost/Evt*
	Scheduled Costs / Event	*Current*	*Unmod*	*Mod*	*Numbers (xx.0) Reference Input Page*
	O & I Labor	$1,131.20	$1,131.20	$1,131.20	(18.0 + 19.0 * (20.0 + 21.0)) * BLR
	Depot Labor	$433.00	$433.00	$433.00	(24.0 * 25.0) * DLR
(N)	Total Labor	$1,564.20	$1,564.20	$1,564.20	
	O & I Repair	$500.00	$500.00	$500.00	(22.0 * 23.0)
	Depot Repair	$2,500.00	$2,500.00	$200.00	(26.0 * 27.0)
	Scrap Cost	$3,125.00	$3,125.00	$250.00	(28.0 * 29.0)
(P)	Total Material	$6,125.00	$6,125.00	$950.00	
	Test Labor & Fuel	$234.21	$234.21	$234.21	(30.0 * G17 * G19) + (30.0 * 2 * BLR)
(Q)	Total Material Incl Test	$6,359.21	$6,359.21	$1,184.21	

			Proposed		*Equations to Calculate Cost/Evt*
	Unscheduled Costs / Event	*Current*	*Unmod*	*Mod*	*Numbers (xx.0) Reference Input Page*
	O & I Labor	$1,131.20	$1,131.20	$1,131.20	(32.0 + 33.0 * (34.0 + 35.0)) * BLR
	Depot Labor	$433.00	$433.00	$433.00	(38.0 * 39.0) * DLR
(R)	Total Labor	$1,631.20	$1,631.20	$1,564.20	
	O & I Repair	$500.00	$500.00	$500.00	(36.0 * 37.0)
	Depot Repair	$31.25	$31.25	$2.50	(40.0 * 41.0)
	Scrap	$625.00	$625.00	$5.00	(42.0 * 43.0)
(S)	Total Material	$1,156.25	$1,156.25	$507.50	
	Test Labor & Fuel	$234.21	$234.21	$234.21	(44.0 * G17 * G19) + (44.0 * 2 * BLR)
(T)	Total Material Incl Test	$1,390.46	$1,390.46	$741.71	
	Second Damage & Incidental	$100,000.00	$100,000.00	$100,000.00	(45.0 + 46.0)
(U)	GrandTotal Material	$101,390.46	$101,390.46	$100,741.71	

Summary Page Equations

1)	Production Engine Cost	(A + G)
2)	Operational Engine Modification Cost	(H_Total * (B + C))
3)	Follow-on Maintenance Material Cost	((K_Cur * U_Cur + J_Cur *Q_Cur) - (K_ProUnmod * U_ProUnmod + J_ProUnmod * Q_ProUnmod + K_ProMod * U_ProMod + J_ProMod * Q_ProMod) -(H_Unsch * T + H_Sch * P))
4)	Follow-on Maintenance Labor Cost	((K_Cur * R_Cur + J_Cur * N_Cur) - (K_ProUnmod * R_ProUnmod + J_ProUnmod * N_ProUnmod + K_ProMod * R_ProMod + J_ProMod * N_ProMod))
5)	Publications Cost	(D)
6)	Support Equipment Cost	(E)
7)	Part Number Cost	(DI48 + DJ48 + L64/1000) - (BW48)
8)	Operational Fuel Cost	(L_Cur * G17 * G20) - (L_ProUnmod + L_ProMod * (1 - 48)) * G17 * G20
9)	Aircraft Loss Cost	(F * M)

STANDARD HISTORY FILE

(N) Calendar Year	(O) No. of Available Mod Months: Production	(P) No. of Available Mod Months: Field	(Q) Engine Deliveries: Annual	(R) Engine Deliveries: Cumulative	(S) Annual Engine Flight Hours: Fleet	(T) Annual Engine Flight Hours: Average per Engine	(U) Cumulative Engines	(V) Attrition: Cumulative Whole Engine	(W) Annual Whole Engines
1985	0	0	0	0	0	240.00	0.00	0	0
1986	0	0	100	100	12,000	240.00	0.24	0	0
1987	0	0	125	225	38,880	240.00	1.02	1	1
1988	0	0	125	349	68,880	240.00	2.40	2	1
1989	0	0	150	498	101,520	240.00	4.43	4	2
1990	0	0	100	596	131,280	240.00	7.05	7	3
1991	8	5	50	643	148,560	240.00	10.02	10	3
1992	12	12	0	640	153,840	240.00	13.10	13	3
1993	12	12	0	637	153,120	240.00	16.16	16	3
1994	12	12	0	634	152,400	240.00	19.21	19	3
1995	12	12	0	631	151,680	240.00	22.24	22	3
1996	12	12	0	628	150,960	240.00	25.26	25	3
1997	12	12	0	625	150,240	240.00	28.27	28	3
1998	12	12	0	622	149,520	240.00	31.26	31	3
1999	12	12	0	619	148,800	240.00	34.23	34	3
2000	12	12	0	616	148,080	240.00	37.20	37	3
2001	12	12	0	613	147,360	240.00	40.14	40	3
2002	12	12	0	610	146,640	240.00	43.08	43	3
2003	12	12	0	607	145,920	240.00	45.99	45	2
2004	12	12	0	605	145,440	240.00	48.90	48	3
2005	12	12	0	602	144,720	240.00	51.80	51	3
2006	12	12	(91)	508	133,200	240.00	54.46	54	3
2007	12	12	(114)	391	107,760	240.00	56.62	56	2
2008	12	12	(114)	275	79,920	240.00	58.21	58	2
2009	12	12	(137)	136	49,200	240.00	59.20	59	1
2010	12	12	(91)	44	21,600	240.00	59.63	59	0
2011	12	12	(44)	0	5,280	240.00	59.74	59	0
2012	12	12	0	0	0	240.00	59.74	59	0
2013	12	12	0	0	0	240.00	59.74	59	0
2014	12	12	0	0	0	240.00	59.74	59	0
2015	12	12	0	0	0	240.00	59.74	59	0
2016	12	12	0	0	0	240.00	59.74	59	0
2017	12	12	0	0	0	240.00	59.74	59	0
Totals		Engines Delivered →	650	EFH →	2,986,800				59

EFH / Year = 240
TAC / EFH= 3.0
TOT / EFH= 1.5

Test Fuel - Gallons / Hour = 150
Flight Fuel - Gallons / Hour = 150
Aircraft Cost $0

Engine Attrition / EFH 0.00002

(Y) Done by Attrition	(Z) Upgraded Engines: Done by 1st Opp.	(AA) Done by Forced	(AB) Done in Prod.	(AC) Cumulative Kits Installed	(AD) Cumulative Kit EFH
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	56	0	33	56	13440
0	140	0	33	196	47040
0	119	0	33	315	75600
0	85	0	33	400	96000
0	60	0	33	460	110400
0	42	0	33	502	120480
0	29	0	33	531	127440
0	18	0	33	549	131760
0	12	0	33	561	134640
0	9	0	33	570	136800
0	5	0	33	575	138000
0	2	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	0	0	33	577	138480
0	577	0			

Maximum Kits/Yr

(AE) No. of Kits Over and Above MAXKITs	(AF) Unmod Scheduled Available Year	(AG) EFH for Proposed Unmod Sched Inspections	(AH) Mod Scheduled Available Year	(AI) EFH for Proposed Mod Sched Inspections	(AJ) EFH for Current Sched Inspections	Events due to Unscheduled Event Rate: (AK) Current Side Events Cumulative Decimal	(AL) Current Side Events Cumulative Integer	(AM) Current Side Events Annual Integer	(AN) Proposed Side Unmod Events Cumulative Decimal	(AO) Proposed Side Unmod Events Cumulative Integer	(AP) Proposed Side Unmod Events Annual Integer	(AQ) Proposed Side Mod Events Cumulative Decimal	(AR) Proposed Side Mod Events Cumulative Integer	(AS) Proposed Side Mod Events Annual Integer	(AT) Years of Incorporation	Events due to Unsch. Evt. allowing Mod: (AU) Unsched Incorporation Opportunities Cumulative Decimal	(AV) Unsched Incorporation Opportunities Cumulative Integer	(AW) Unsched Incorporation Opportunities Annual Integer	(AX) Kit Incorporation Events Unsched	(AY) Kit Incorporation Events Sched
0	1987	0	1987	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0	0.00	0	0	0	0
0	1988	0	1987	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0	0.00	0	0	0	0
0	1988	0	1988	0	0	0.24	0	0	0.24	0	0	0.00	0	0	0	0.24	0	0	0	0
0	1988	0	1988	0	0	1.02	1	1	1.02	1	1	0.00	0	0	0	1.02	1	1	0	0
0	1988	68880	1988	0	68880	2.40	2	1	2.40	2	1	0.00	0	0	0	2.40	2	1	0	0
0	1988	101520	1988	0	101520	4.43	4	2	4.43	4	2	0.00	0	0	0	4.43	4	2	0	0
0	1988	131280	1988	0	131280	7.05	7	3	7.05	7	3	0.00	0	0	1	7.05	7	3	1.25	84.583333
0	1988	138000	1988	10560	148560	10.02	10	3	9.81	9	2	0.02	0	0	1	9.81	9	2	2	136
0	1988	115680	1988	38160	153840	13.10	13	3	12.12	12	3	0.10	0	0	1	12.12	12	3	3	116
0	1988	84000	1988	69120	153120	16.16	16	3	13.80	13	1	0.24	0	0	1	13.80	13	1	1	84
0	1988	58800	1988	93600	152400	19.21	19	3	14.98	14	1	0.42	0	0	1	14.98	14	1	1	59
0	1988	40560	1988	111120	151680	22.24	22	3	15.79	15	1	0.65	0	0	1	15.79	15	1	1	41
0	1988	27600	1988	123360	150960	25.26	25	3	16.34	16	1	0.89	0	0	1	16.34	16	1	1	28
0	1988	18480	1988	131760	150240	28.27	28	3	16.71	16	0	1.16	1	1	1	16.71	16	0	0	18
0	1988	12000	1988	137520	149520	31.26	31	3	16.95	16	0	1.43	1	0	1	16.95	16	0	0	12
0	1988	7680	1988	141120	148800	34.23	34	3	17.11	17	1	1.71	1	0	1	17.11	17	1	1	8
0	1988	4560	1988	143520	148080	37.20	37	3	17.20	17	0	2.00	1	0	1	17.20	17	0	0	5
0	1988	2160	1988	145200	147360	40.14	40	3	17.24	17	0	2.29	2	1	1	17.24	17	0	0	2
0	1988	480	1988	146160	146640	43.08	43	3	17.25	17	0	2.58	2	0	0	17.25	17	0	0	0
0	1988	0	1988	145920	145920	45.99	45	2	17.25	17	0	2.87	2	0	0	17.25	17	0	0	0
0	1988	0	1988	145440	145440	48.90	48	3	17.25	17	0	3.17	3	1	0	17.25	17	0	0	0
0	1988	0	1988	144720	144720	51.80	51	3	17.25	17	0	3.45	3	0	0	17.25	17	0	0	0
0	1988	0	1988	133200	133200	54.46	54	3	17.25	17	0	3.72	3	0	0	17.25	17	0	0	0
0	1988	0	1988	107760	107760	56.62	56	2	17.25	17	0	3.94	3	0	0	17.25	17	0	0	0
0	1988	0	1988	79920	79920	58.21	58	2	17.25	17	0	4.10	4	1	0	17.25	17	0	0	0
0	1988	0	1988	49200	49200	59.20	59	1	17.25	17	0	4.19	4	0	0	17.25	17	0	0	0
0	1988	0	1988	21600	21600	59.63	59	0	17.25	17	0	4.24	4	0	0	17.25	17	0	0	0
0	1988	0	1988	5280	5280	59.74	59	0	17.25	17	0	4.25	4	0	0	17.25	17	0	0	0
0	1988	0	1988	0	0	59.74	59	0	17.25	17	0	4.25	4	0	0	17.25	17	0	0	0
0	1988	0	1988	0	0	59.74	59	0	17.25	17	0	4.25	4	0	0	17.25	17	0	0	0
0	1988	0	1988	0	0	59.74	59	0	17.25	17	0	4.25	4	0	0	17.25	17	0	0	0
0	1988	0	1988	0	0	59.74	59	0	17.25	17	0	4.25	4	0	0	17.25	17	0	0	0
0	1988	0	1988	0	0	59.74	59	0	17.25	17	0	4.25	4	0	0	17.25	17	0	0	0
								59			17			4	12			17	11.25	585.58333

9999 Unmod Side Inspection Interval in TACs 3000
Unmod Side Inspection Interval in EFH 950.0
which is 3 Years / Inspection Interval
and 0 Inspections / Year

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

CURRENT CONFIGURATION

CEA VERSION 2.0 11/19/93
Pg. 3a

(BA)	(BC) Avg. No. Engines	(BD)	(BE) Yearly Engine Flight Hours	(BF)	(BG) Unsch. Events	(BH)	(BI) Sched. Events	(BJ)	(BM)	(BN) Engine Kits	(BO)	(BP)	(BQ) Spare Kits	(BR)
Calendar Year	Unmod Engines	Mod Engines	Unmod EFH (1000 EFH)	Mod EFH (1000 EFH)	Unmod	Mod	Unmod	Mod	No. Installed	Mat'l Cost $(000)	Labor Cost $(000)	No. Installed	Mat'l Cost $(000)	Labor Cost $(000)
1985	0		0.000		0		0							
1986	50		12.000		0		0							
1987	162		38.880		0		0							
1988	287		68.880		1		0							
1989	423		101.520		1		69							
1990	547		131.280		2		102							
1991	619		148.560		3		131							
1992	641		153.840		3		149							
1993	638		153.120		3		154							
1994	635		152.400		3		153							
1995	632		151.680		3		152							
1996	629		150.960		3		152							
1997	626		150.240		3		151							
1998	623		149.520		3		150							
1999	620		148.800		3		150							
2000	617		148.080		3		149							
2001	614		147.360		3		148							
2002	611		146.640		3		147							
2003	608		145.920		3		147							
2004	606		145.440		2		146							
2005	603		144.720		3		145							
2006	555		133.200		3		145							
2007	449		107.760		3		133							
2008	333		79.920		2		108							
2009	205		49.200		2		80							
2010	90		21.600		1		49							
2011	22		5.280		0		22							
2012	0		0.000		0		0							
2013	0		0.000		0		0							
2014	0		0.000		0		0							
2015	0		0.000		0		0							
2016	0		0.000		0		0							
2017	0		0.000		0		0							
Totals			2,986.800		59		2932							

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

CURRENT CONFIGURATION

CEA VERSION 2.0 11/18/93
Pg. 3b

(BT) Calendar Year	(BU) One-Time Costs $(000)	(BW) Part Maint Cost Unmod $(000)	(BX) Part Maint Cost Mod $(000)	(BY) Unmod Unsch Cost (Minus Kit Instl) Labor $(000)	(BZ) Unmod Unsch Cost (Minus Kit Instl) Material $(000)	(CA) Unmod Sched Cost (Minus Kit Instl) Labor $(000)	(CB) Unmod Sched Cost (Minus Kit Instl) Material $(000)	(CC) Mod Unsched Cost Labor $(000)	(CD) Mod Unsched Cost Material $(000)	(CE) Mod Sched Cost Labor $(000)	(CF) Mod Sched Cost Material $(000)	(CG) Current Total Cost $(000)	(CH) Operational Fuel Gal/Yr (000)	(CI) Operational Fuel Cost $(000)	(CK) Total Cost Curr Config w/ Fuel $(000)
1985		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
1986		$1.00		$0	$0	$0	$0					$1	N/A	N/A	$1
1987		$1.00		$0	$0	$0	$0					$1	N/A	N/A	$1
1988		$1.00		$2	$101	$0	$0					$104	N/A	N/A	$104
1989		$1.00		$2	$101	$108	$439					$651	N/A	N/A	$651
1990		$1.00		$3	$203	$180	$649					$1,015	N/A	N/A	$1,015
1991		$1.00		$5	$304	$205	$833					$1,348	N/A	N/A	$1,348
1992		$1.00		$5	$304	$233	$948					$1,490	N/A	N/A	$1,490
1993		$1.00		$5	$304	$241	$979					$1,530	N/A	N/A	$1,530
1994		$1.00		$5	$304	$239	$973					$1,522	N/A	N/A	$1,522
1995		$1.00		$5	$304	$238	$967					$1,514	N/A	N/A	$1,514
1996		$1.00		$5	$304	$238	$967					$1,514	N/A	N/A	$1,514
1997		$1.00		$5	$304	$236	$960					$1,506	N/A	N/A	$1,506
1998		$1.00		$5	$304	$235	$954					$1,498	N/A	N/A	$1,498
1999		$1.00		$5	$304	$235	$954					$1,498	N/A	N/A	$1,498
2000		$1.00		$5	$304	$233	$948					$1,490	N/A	N/A	$1,490
2001		$1.00		$5	$304	$232	$941					$1,483	N/A	N/A	$1,483
2002		$1.00		$5	$304	$230	$935					$1,475	N/A	N/A	$1,475
2003		$1.00		$5	$304	$230	$935					$1,475	N/A	N/A	$1,475
2004		$1.00		$3	$203	$228	$926					$1,364	N/A	N/A	$1,364
2005		$1.00		$5	$304	$227	$922					$1,459	N/A	N/A	$1,459
2006		$1.00		$5	$304	$227	$922					$1,459	N/A	N/A	$1,459
2007		$1.00		$5	$304	$208	$846					$1,364	N/A	N/A	$1,364
2008		$1.00		$3	$203	$169	$687					$1,063	N/A	N/A	$1,063
2009		$1.00		$3	$203	$125	$509					$841	N/A	N/A	$841
2010		$1.00		$2	$101	$77	$312					$492	N/A	N/A	$492
2011		$1.00		$0	$0	$34	$140					$175	N/A	N/A	$175
2012		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2013		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2014		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2015		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2016		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2017		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
Totals		$26.00		$92	$5,982	$4,586	$18,645					$29,332	0	$0	$29,332
$ (000) / Event used in the above columns:				$1.564	$101.390	$1.564	$6.359								

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

PROPOSED CONFIGURATION

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(CM) Calendar Year	(CN) Engines Mod in Prod	(CO) Avg. No. Engines: Unmod Engines	(CP) Avg. No. Engines: Mod Engines	(CQ) Yearly Engine Flight Hours: Unmod EFH EFH / 1000	(CR) Yearly Engine Flight Hours: Mod EFH EFH / 1000	(CS) Unsch. Events: Unmod	(CT) Unsch. Events: Mod	(CU) Sched. Events: Unmod	(CV) Sched. Events: Mod	(CW) A/C Loss Events: Cum	(CX) A/C Loss Events: Annual	(CY) Engine Kits: No. Installed	(CZ) Engine Kits: Mat'l Cost $(000)	(DA) Engine Kits: Labor Cost $(000)	(DB) Spare Kits: No. Installed	(DC) Spare Kits: Mat'l Cost $(000)	(DD) Spare Kits: Labor Cost $(000)
1985	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
1986	0	50	0	12.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
1987	0	162	0	38.880	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
1988	0	287	0	68.880	0.000	1	0	0	0	0.0	0	0	$0	$0	0	$0	$0
1989	0	423	0	101.520	0.000	1	0	69	0	0.0	0	0	$0	$0	0	$0	$0
1990	0	547	0	131.280	0.000	2	0	102	0	0.0	0	0	$0	$0	0	$0	$0
1991	33	575	44	138.000	10.560	3	0	131	0	0.0	0	56	$840	$52	0	$0	$0
1992	0	482	159	115.680	38.160	2	0	138	7.92	0.0	0	140	$2,100	$130	0	$0	$0
1993	0	350	288	84.000	69.120	3	0	116	28.62	0.0	0	119	$1,785	$111	0	$0	$0
1994	0	245	390	58.800	93.600	1	0	84	51.84	0.0	0	85	$1,275	$79	0	$0	$0
1995	0	169	463	40.560	111.120	1	0	59	70.2	0.0	0	60	$900	$56	0	$0	$0
1996	0	115	514	27.600	123.360	1	0	41	83.34	0.0	0	42	$630	$39	0	$0	$0
1997	0	77	549	18.480	131.760	1	0	28	92.52	0.0	0	29	$435	$27	0	$0	$0
1998	0	50	573	12.000	137.520	0	1	18	98.82	0.0	0	18	$270	$17	0	$0	$0
1999	0	32	588	7.680	141.120	0	0	12	103.14	0.0	0	12	$180	$11	0	$0	$0
2000	0	19	598	4.560	143.520	1	0	8	105.84	0.0	0	9	$135	$8	0	$0	$0
2001	0	9	605	2.160	145.200	0	0	5	107.64	0.0	0	5	$75	$5	0	$0	$0
2002	0	2	609	0.480	146.160	0	1	2	108.9	0.0	0	2	$30	$2	0	$0	$0
2003	0	0	608	0.000	145.920	0	0	0	109.62	0.0	0	0	$0	$0	0	$0	$0
2004	0	0	606	0.000	145.440	0	0	0	109.44	0.0	0	0	$0	$0	0	$0	$0
2005	0	0	603	0.000	144.720	0	1	0	109.08	0.0	0	0	$0	$0	0	$0	$0
2006	0	0	555	0.000	133.200	0	0	0	108.54	0.0	0	0	$0	$0	0	$0	$0
2007	0	0	449	0.000	107.760	0	0	0	99.9	0.0	0	0	$0	$0	0	$0	$0
2008	0	0	333	0.000	79.920	0	0	0	80.82	0.0	0	0	$0	$0	0	$0	$0
2009	0	0	205	0.000	49.200	0	1	0	59.94	0.0	0	0	$0	$0	0	$0	$0
2010	0	0	90	0.000	21.600	0	0	0	36.9	0.0	0	0	$0	$0	0	$0	$0
2011	0	0	22	0.000	5.280	0	0	0	16.2	0.0	0	0	$0	$0	0	$0	$0
2012	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
2013	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
2014	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
2015	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
2016	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
2017	0	0	0	0.000	0.000	0	0	0	0	0.0	0	0	$0	$0	0	$0	$0
Sub Totals	33			862 560	2,124 240	17	4	813	1589		0	577	$8,655	$537	0	$0	$0
Combined Unmodified & Modified Totals				2986.8		21		2402									

	Total	$(000) / Kit
Kits Installed	577	"N/A"
Kit Material Cost	$8,655	$15 000
Kit Labor Cost	$537	$0 931

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

PROPOSED CONFIGURATION

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(DF) Calender Year	(DG) One-Time Costs $(000)	(DH) Delta Prod. Cost $(000)	(DI) Part Maint Cost Unmod $(000)	(DJ) Part Maint Cost Mod $(000)	(DK) Unmod Unsch Cost (Minus Kit Instl) Labor $(000)	(DL) Unmod Unsch Cost (Minus Kit Instl) Material $(000)	(DM) Unmod Sched Cost (Minus Kit Instl) Labor $(000)	(DN) Unmod Sched Cost (Minus Kit Instl) Material $(000)	(DO) Mod Unsched Cost Labor $(000)	(DP) Mod Unsched Cost Material $(000)	(DQ) Mod Sched Cost Labor $(000)	(DR) Mod Sched Cost Material $(000)	(DS) Proposed Total Cost $(000)	(DT) Operational Fuel Gal/Yr (000)	(DU) Operational Fuel Cost $(000)	(DV) A/C Loss Delta $(000)	(DW) Total Cost Prop Config w/ Fuel,A/C $(000)
1985	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
1986	$0	$0	$1.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$1	N/A	N/A	$0	$1
1987	$0	$0	$1.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$1	N/A	N/A	$0	$1
1988	$0	$0	$1.00	$0.00	$2	$101	$0	$0	$0	$0	$0	$0	$104	N/A	N/A	$0	$104
1989	$0	$0	$1.00	$0.00	$2	$101	$108	$439	$0	$0	$0	$0	$651	N/A	N/A	$0	$651
1990	$0	$0	$1.00	$0.00	$3	$203	$160	$649	$0	$0	$0	$0	$1,015	N/A	N/A	$0	$1,015
1991	$9	$330	$1.00	$1.00	$5	$304	$205	$833	$0	$0	$0	$0	$2,580	N/A	N/A	$0	$2,580
1992	$0	$0	$1.00	$1.00	$3	$203	$216	$878	$0	$0	$12	$9	$3,553	N/A	N/A	$0	$3,553
1993	$0	$0	$1.00	$1.00	$5	$304	$181	$738	$0	$0	$45	$34	$3,204	N/A	N/A	$0	$3,204
1994	$0	$0	$1.00	$1.00	$2	$101	$131	$534	$0	$0	$81	$61	$2,267	N/A	N/A	$0	$2,267
1995	$0	$0	$1.00	$1.00	$2	$101	$92	$375	$0	$0	$110	$83	$1,721	N/A	N/A	$0	$1,721
1996	$0	$0	$1.00	$1.00	$2	$101	$64	$261	$0	$0	$130	$99	$1,328	N/A	N/A	$0	$1,328
1997	$0	$0	$1.00	$1.00	$2	$101	$44	$178	$0	$0	$145	$110	$1,043	N/A	N/A	$0	$1,043
1998	$0	$0	$1.00	$1.00	$0	$0	$28	$114	$2	$101	$155	$117	$805	N/A	N/A	$0	$805
1999	$0	$0	$1.00	$1.00	$0	$0	$19	$76	$0	$0	$161	$122	$572	N/A	N/A	$0	$572
2000	$0	$0	$1.00	$1.00	$2	$101	$13	$51	$0	$0	$166	$125	$603	N/A	N/A	$0	$603
2001	$0	$0	$1.00	$1.00	$0	$0	$8	$32	$0	$0	$168	$127	$417	N/A	N/A	$0	$417
2002	$0	$0	$1.00	$1.00	$0	$0	$3	$13	$2	$101	$170	$129	$451	N/A	N/A	$0	$451
2003	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$171	$130	$302	N/A	N/A	$0	$302
2004	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$171	$130	$302	N/A	N/A	$0	$302
2005	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$2	$101	$171	$129	$403	N/A	N/A	$0	$403
2006	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$170	$129	$299	N/A	N/A	$0	$299
2007	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$156	$118	$276	N/A	N/A	$0	$276
2008	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$126	$96	$223	N/A	N/A	$0	$223
2009	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$2	$101	$94	$71	$268	N/A	N/A	$0	$268
2010	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$58	$44	$102	N/A	N/A	$0	$102
2011	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$0	$25	$19	$46	N/A	N/A	$0	$46
2012	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2013	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2014	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2015	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2016	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2017	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
Sub Totals	$9	$330	$17.00	$21.00	$27	$1,724	$1,272	$5,170	$6	$403	$2,486	$1,882	$22,538	0	$0	$0	$22,538
Combined Unmodified & Modified Totals			$38.00		$1,750		$6,442			$409		$4,368					
$ (000) / Event used in the above columns:					$1.564	$101.390	$1.564	$6.359	$1.564	$100.742	$1.564	$1.184					

(DY) CAL. YEAR	(DZ) Expenditures Current $(000)	(EA) Proposed $(000)	(EB) Delta Cashflow Yearly Savings $(000)	(EC) Cumulative Savings $(000)	(ED) Cumulative NPV at 10% $(000)
1985	$0	$0	$0	$0	$0
1986	$1	$1	$0	$0	$0
1987	$1	$1	$0	$0	$0
1988	$104	$104	$0	$0	$0
1989	$651	$651	$0	$0	$0
1990	$1,015	$1,015	$0	$0	$0
1991	$1,348	$2,580	($1,232)	($1,232)	($1,232)
1992	$1,490	$3,553	($2,063)	($3,295)	($3,107)
1993	$1,530	$3,204	($1,674)	($4,969)	($4,491)
1994	$1,522	$2,267	($745)	($5,714)	($5,051)
1995	$1,514	$1,721	($207)	($5,921)	($5,192)
1996	$1,514	$1,328	$186	($5,735)	($5,076)
1997	$1,506	$1,043	$463	($5,271)	($4,815)
1998	$1,498	$805	$693	($4,578)	($4,459)
1999	$1,498	$572	$927	($3,652)	($4,027)
2000	$1,490	$603	$888	($2,764)	($3,650)
2001	$1,483	$417	$1,065	($1,698)	($3,240)
2002	$1,475	$451	$1,023	($675)	($2,881)
2003	$1,475	$302	$1,172	$497	($2,507)
2004	$1,364	$302	$1,062	$1,559	($2,200)
2005	$1,459	$403	$1,056	$2,615	($1,922)
2006	$1,459	$299	$1,159	$3,774	($1,644)
2007	$1,364	$276	$1,088	$4,862	($1,407)
2008	$1,063	$223	$840	$5,702	($1,241)
2009	$841	$268	$573	$6,275	($1,138)
2010	$492	$102	$390	$6,664	($1,075)
2011	$175	$46	$130	$6,794	($1,055)
2012	$0	$0	$0	$6,794	($1,055)
2013	$0	$0	$0	$6,794	($1,055)
2014	$0	$0	$0	$6,794	($1,055)
2015	$0	$0	$0	$6,794	($1,055)
2016	$0	$0	$0	$6,794	($1,055)
2017	$0	$0	$0	$6,794	($1,055)
Totals	$29,332	$22,538	$6,794		
NPV	$15,532	$16,588	($1,055)		

Base Year is 1991
NPV Rate 10%

APPENDIX B

NON-INTEGERIZED CEAMOD ANALYSIS PACKAGE PRINTOUT

Appendix B is an example of an Engineering Change Proposal (ECP) Cost Effectiveness Analysis Package printout based on a test data base provided by General Electric. This package was prepared using the non-integerized revision to CEAMOD as described in Chapter III. The three additional pages described at the end of Chapter II are included.

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA
TASK/ECP: Task 000

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CEA Guru

Sample text which appears on page 5. Line 1
Sample line 2
Sample line 3
Sample line 4
Sample line 5
Sample line 6
Sample line 7
Sample line 8
Sample line 9
Last Line Saved. Line 10

SUMMARY - Delta between current and proposed configurations.
All values shown are THOUSANDS of fiscal year 1991 dollars.

		Cost	Savings
1)	Production Engine Cost	$333 K	
2)	Operational Engine Modification Cost	$9,187 K	
3)	Follow-on Maintenance Material Cost		$15,461 K
4)	Follow-on Maintenance Labor Cost		$888 K
5)	Publications Cost	$2 K	
6)	Support Equipment Cost	$1 K	
7)	Part Number Cost	$18 K	
8)	Operational Fuel Cost		
9)	Aircraft Loss Cost		
	Totals	$9,541 K	$16,350 K

Net Delta Dollar Impact	$6,809 K

Net Present Value at	10%	($1,099)K

ASSUMPTIONS

a)	Incorporation in Production engines will begin in		May	1991
b)	Number of engines produced with this change is			33
c)	Number of spare units incorporating this change is			0
d)	Modification of operational engines can begin in		Aug	1991
e)	Incorporation of this change in operational engines will be accomplished by --->	1st Opportunity	at	Depot
f)	Total kits installed out of total engines not modified in production is	577	of	617
g)	Total engines lost to attrition is			59.7422
h)	Total engines retired unmodified is			0
i)	Estimated yearly flying hours	240		EFH / Year

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA
TASK/ECP: Task 000

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Task Incorporation Input

1.0	Incorporation Style: (1,2 or 3) 1 = Attrition 2 = Retrofit at 1st Opportunity 3 = Forced Retrofit		2
		Kits / Month →	0
2.0	Does Kit Cost Replace Normal Maint. Material Cost? 1=Yes 0=No		0
3.0	Delta Production Cost		$10,000
4.0	Kit Hardware Cost - $ / Engine		$15,000
5.0	Kit Labor Manhours at O&I		2
6.0	Kit Labor Manhours at Depot		20
7.0	Technical Pubs Cost - Total $		$500
8.0	TCTO Cost - Total $		$1,500
9.0	Tooling/Support Equipment Cost-Total $		$500
10.0	Spare Parts Factor		0%
11.0	Scheduled % Events being Modified		100%
12.0	Unscheduled % Events being Modified		100%
13.0	Unscheduled Event Rate allowing Modification		0.020
14.0	Production Incorporation Date	Year →	1991
15.0	Field Incorporation Date	Year →	1991

Month → 5
Month → 8

Standard Inputs	
Fiscal Year Dollars	1991
NPV Rate	10%
Labor Cost / Manhour at O&I	$32.32
Labor Cost / Manhour at Depot	$43.30
Cost to introduce new P/N - $ / PN	$1,524
Cost to Maintain each P/N / Year	$250
Fuel Cost / Gallon	$0.61
Test Fuel - Gallons / Hour	150
Flight Fuel - Gallons / Hour	150
EFH / Year	240
TAC / EFH Ratio	3.00
TOT / EFH Ratio	1.50
Aircraft Cost	$0

		CURRENT	PROPOSED
Scheduled Input			
16.0	Scheduled Maintenance Interval (TAC's)	3000	4000
17.0	Calculated Scheduled Maintenance Interval Rate/1000 EFH	1.000	0.750
18.0	Scheduled Manhours to Inspect at O level	0.0	0.0
19.0	Scheduled % Removed at O&I level	100%	100%
20.0	Scheduled Manhours to Remove/Replace at O level	10.0	10.0
21.0	Scheduled Manhours at I level	25.0	25.0
22.0	Scheduled % at O&I requiring Repair	100%	100%
23.0	Scheduled Repair Cost at O&I level	$500	$500
24.0	Scheduled % Returned to Depot	100%	100%
25.0	Scheduled Manhours at Depot	10.0	10.0
26.0	Scheduled % at Depot requiring Repair	10%	1%
27.0	Scheduled Repair Cost at Depot	$25,000	$20,000
28.0	Scheduled % Scrapped	5%	1%
29.0	Hardware Cost to Scrap	$62,500	$50,000
30.0	Scheduled Engine Test Time	1.50	1.50
Unscheduled Input			
31.0	Unscheduled Event Rate/1000 EFH	0.020	0.002
32.0	Unscheduled Manhours at O level	0.0	0.0
33.0	Unscheduled % Removed at O&I level	100%	100%
34.0	Unscheduled Manhours to Remove/Replace at O level	10.0	10.0
35.0	Unscheduled Manhours at I level	25.0	25.0
36.0	Unscheduled % at O&I requiring Repair	100%	100%
37.0	Unscheduled Repair cost at O&I level	$500	$500
38.0	Unscheduled % Returned to Depot	100%	100%
39.0	Unscheduled Manhours at Depot	10.0	10.0
40.0	Unscheduled % at Depot requiring Repair	3%	0%
41.0	Unscheduled Repair Cost at Depot	$1,250	$1,000
42.0	Unscheduled % Scrapped	1%	0%
43.0	Hardware Cost to Scrap	$62,500	$5,000
44.0	Unscheduled Engine Test Time	1.50	1.50
45.0	Unscheduled Secondary Damage Costs	$100,000	$100,000
46.0	Unscheduled Incidental Costs	$0	$0
47.0	Number of P/N's	4	4
Optional Input			
48.0	% Improvement in Specific Fuel Consumption from Current to Proposed		0%
49.0	Aircraft Loss Rate Improvement / 1,000,000 EFH		0.00

CEA Guru

Calculated Costs / Event

Kit Cost	$15,000.00
Labor Cost to Install the Kit	$930.64
Total Cost to Install the Kit	$15,930.64

Scheduled	Current	Proposed
O & I Labor Cost / Scheduled Event	$1,131.20	$1,131.20
Depot Labor Cost / Scheduled Event	$433.00	$433.00
Total Labor Cost / Scheduled Event	$1,564.20	$1,564.20
O & I Repair Cost / Scheduled Event	$500.00	$500.00
Depot Repair Cost / Scheduled Event	$2,500.00	$200.00
Scrap Cost / Scheduled Event	$3,125.00	$250.00
Total Material Cost / Scheduled Event	$6,125.00	$950.00
Test Labor & Fuel Cost / Scheduled Event	$234.21	$234.21
Total Material Incl Test Cost / Scheduled Event	$6,359.21	$1,184.21

Unscheduled	Current	Proposed
O & I Labor Cost / Unscheduled Event	$1,131.20	$1,131.20
Depot Labor Cost / Unscheduled Event	$433.00	$433.00
Total Labor Cost / Unscheduled Event	$1,564.20	$1,564.20
O & I Repair Cost / Unscheduled Event	$500.00	$500.00
Depot Repair Cost / Unscheduled Event	$31.25	$2.50
Scrap Cost / Unscheduled Event	$625.00	$5.00
Total Material Cost / Unscheduled Event	$1,156.25	$507.50
Test Labor & Fuel Cost / Unscheduled Event	$234.21	$234.21
Total Material Incl Test Cost / Unscheduled Event	$1,390.46	$741.71
Second Dam & Inced Cost / Unscheduled Event	$100,000.00	$100,000.00
GrandTotal Material Cost / Unscheduled Event	$101,390.46	$100,741.71
Cost to Introduce the New Part Numbers	N/A	$6,096.00

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

Interim Calculations

CEA VERSION 2.0

11/18/93

(A)	Delta Production Cost	$10,000.00	(D)	Publications Cost	$2,000.00
(B)	Kit Cost	$15,000.00	(E)	Support Equipment	$500.00
(C)	Labor Cost to Install the Kit	$930.64	(F)	Aircraft Cost	$0.00

	Modification Events	***Unscheduled***	***Scheduled***	***Spares***	***Total***
(G)	Engines Modified in Production				33
(H)	Retrofit Events	11.29179266	565.3809728	0	577

			Proposed	
	Operational Events & EFH	***Current***	***Unmod***	***Mod***
(J)	Scheduled Events	2862.035776	743.4933515	1589
(K)	Unscheduled Events	59.63711691	17.25044162	4
(L)	Engine Flight Hours (In Thousands)	2,987.111	863.313	2,123.798
(M)	Aircraft Losses Delta	N/A	N/A	0

			Proposed		***Equations to Calculate Cost/Evt***
	Scheduled Costs / Event	***Current***	***Unmod***	***Mod***	***Numbers (xx.0) Reference Input Page***
	O & I Labor	$1,131.20	$1,131.20	$1,131.20	(18.0 + 19.0 * (20.0 + 21.0)) * BLR
	Depot Labor	$433.00	$433.00	$433.00	(24.0 * 25.0) * DLR
(N)	Total Labor	$1,564.20	$1,564.20	$1,564.20	
	O & I Repair	$500.00	$500.00	$500.00	(22.0 * 23.0)
	Depot Repair	$2,500.00	$2,500.00	$200.00	(26.0 * 27.0)
	Scrap Cost	$3,125.00	$3,125.00	$250.00	(28.0 * 29.0)
(P)	Total Material	$6,125.00	$6,125.00	$950.00	
	Test Labor & Fuel	$234.21	$234.21	$234.2;	(30.0 * G17 * G19) + (30.0 * 2 * BLR)
(Q)	Total Material Incl Test	$6,359.21	$6,359.21	$1,184.21	

			Proposed		***Equations to Calculate Cost/Evt***
	Unscheduled Costs / Event	***Current***	***Unmod***	***Mod***	***Numbers (xx.0) Reference Input Page***
	O & I Labor	$1,131.20	$1,131.20	$1,131.20	(32.0 + 33.0 * (34.0 + 35.0)) * BLR
	Depot Labor	$433.00	$433.00	$433.00	(38.0 * 39.0) * DLR
(R)	Total Labor	$1,631.20	$1,631.20	$1,564.20	
	O & I Repair	$500.00	$500.00	$500.00	(36.0 * 37.0)
	Depot Repair	$31.25	$31.25	$2.50	(40.0 * 41.0)
	Scrap	$625.00	$625.00	$5.00	(42.0 * 43.0)
(S)	Total Material	$1,156.25	$1,156.25	$507.50	
	Test Labor & Fuel	$234.21	$234.21	$234.21	(44.0 * G17 * G19) + (44.0 * 2 * BLR)
(T)	Total Material Incl Test	$1,390.46	$1,390.46	$741.71	
	Second Damage & Incidental	$100,000.00	$100,000.00	$100,000.00	(45.0 + 46.0)
(U)	GrandTotal Material	$101,390.46	$101,390.46	$100,741.71	

Summary Page Equations

1)	Production Engine Cost	(A + G)
2)	Operational Engine Modification Cost	(H_Total * (B + C))
3)	Follow-on Maintenance Material Cost	((K_Cur * U_Cur + J_Cur *Q_Cur) - (K_ProUnmod * U_ProUnmod + J_ProUnmod * Q_ProUnmod + K_ProMod * U_ProMod + J_ProMod * Q_ProMod) -(H_Unsch * T + H_Sch * P))
4)	Follow-on Maintenance Labor Cost	((K_Cur * R_Cur + J_Cur * N_Cur) - (K_ProUnmod * R_ProUnmod + J_ProUnmod * N_ProUnmod + K_ProMod * R_ProMod + J_ProMod * N_ProMod))
5)	Publications Cost	(D)
6)	Support Equipment Cost	(E)
7)	Part Number Cost	(DI48 + DJ48 + L64/1000) - (BW48)
8)	Operational Fuel Cost	(L_Cur * G17 * G20) - (L_ProUnmod + L_ProMod * (1 - 48)) * G17 * G20
9)	Aircraft Loss Cost	(F * M)

STANDARD HISTORY FILE

(N)	(O) No. of Available Mod Months	(P)	(Q) Engine Deliveries	(R)	(S) Annual Engine Flight Hours	(T)	(U)	(V) Attrition	(W)
Calendar Year	Production	Field	Annual	Cumulative	Fleet	Average per Engine	Cumulative Engines	Cumulative Whole Engine	Annual Engines
1985	0	0	0	0.00	0.00	240.00	0.00	0	0.00
1986	0	0	100	100.00	12,000.00	240.00	0.24	0	0.24
1987	0	0	125	224.76	38,971.20	240.00	1.02	1	0.78
1988	0	0	125	348.98	68,848.87	240.00	2.40	2	1.38
1989	0	0	150	497.60	101,590.10	240.00	4.43	4	2.03
1990	0	0	100	595.57	131,181.05	240.00	7.05	7	2.62
1991	8	5	50	642.95	148,622.40	240.00	10.02	10	2.97
1992	12	12	0	639.98	153,950.87	240.00	13.10	13	3.08
1993	12	12	0	636.90	153,224.69	240.00	16.17	16	3.06
1994	12	12	0	633.83	152,487.47	240.00	19.22	19	3.05
1995	12	12	0	630.78	151,753.76	240.00	22.25	22	3.04
1996	12	12	0	627.75	151,023.58	240.00	25.27	25	3.02
1997	12	12	0	624.73	150,296.92	240.00	28.28	28	3.01
1998	12	12	0	621.72	149,573.75	240.00	31.27	31	2.99
1999	12	12	0	618.73	148,854.06	240.00	34.25	34	2.98
2000	12	12	0	615.75	148,137.83	240.00	37.21	37	2.96
2001	12	12	0	612.79	147,425.05	240.00	40.16	40	2.95
2002	12	12	0	609.84	146,715.70	240.00	43.09	43	2.93
2003	12	12	0	606.91	146,009.76	240.00	46.01	46	2.92
2004	12	12	0	603.99	145,307.22	240.00	48.92	48	2.91
2005	12	12	0	601.08	144,608.06	240.00	51.81	51	2.89
2006	12	12	(91)	507.19	132,992.26	240.00	54.47	54	2.66
2007	12	12	(114)	390.53	107,726.02	240.00	56.63	56	2.15
2008	12	12	(114)	274.37	79,788.30	240.00	58.22	58	1.60
2009	12	12	(137)	135.78	49,218.27	240.00	59.21	59	0.98
2010	12	12	(91)	43.79	21,548.65	240.00	59.64	59	0.43
2011	12	12	(44)	0.00	5,255.26	240.00	59.74	59	0.11
2012	12	12	0	0.00	0.00	240.00	59.74	59	0.00
2013	12	12	0	0.00	0.00	240.00	59.74	59	0.00
2014	12	12	0	0.00	0.00	240.00	59.74	59	0.00
2015	12	12	0	0.00	0.00	240.00	59.74	59	0.00
2016	12	12	0	0.00	0.00	240.00	59.74	59	0.00
2017	12	12	0	0.00	0.00	240.00	59.74	59	0.00
Totals	Engines Delivered -->		650	EFH --->	2,987,111.11				59.74

EFH / Year =	240	Test Fuel - Gallons / Hour =	150	Engine Attrition / EFH	0.00002
TAC / EFH=	3.0	Flight Fuel - Gallons / Hour =	150		
TOT / EFH=	1.5	Aircraft Cost	$0		

(Y) Done by Attrition	(Z) Upgraded Engines Done by 1st Opp.	(AA) Done by Forced	(AB) Done in Prod.	(AC) Cumulative Kits Installed	(AD) Cumulative Kit EFH
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	55.75	0.00	33.33	55.75	13,380.47
0.00	140.69	0.00	33.33	196.44	47,146.26
0.00	118.00	0.00	33.33	314.44	75,466.56
0.00	85.60	0.00	33.33	400.04	96,009.76
0.00	59.92	0.00	33.33	459.96	110,391.59
0.00	41.36	0.00	33.33	501.33	120,318.98
0.00	28.22	0.00	33.33	529.55	127,092.18
0.00	18.96	0.00	33.33	548.51	131,643.34
0.00	12.45	0.00	33.33	560.96	134,631.37
0.00	7.87	0.00	33.33	568.84	136,520.42
0.00	4.65	0.00	33.33	573.49	137,637.18
0.00	2.39	0.00	33.33	575.88	138,211.54
0.00	0.81	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	0.00	0.00	33.33	576.69	138,405.26
0.00	576.69	0.00			

Maximum Kits/Yr

(AE) No. of Kits Over and Above MAXKITs	(AF) Unmod Scheduled Available Year	(AG) EFH for Proposed Unmod Sched Inspections	(AH) Mod Scheduled Available Year	(AI) EFH for Proposed Mod Sched Inspections	(AJ) EFH for Current Sched Inspections	Events due to Unscheduled Event Rate: (AK) Current Side Events Cumulative Decimal	(AL) Current Side Events Cumulative Integer	(AM) Current Side Events Annual Decimal	(AN) Proposed Side Unmod Events Cumulative Decimal	(AO) Proposed Side Unmod Events Cumulative Integer	(AP) Proposed Side Unmod Events Annual Decimal	(AQ) Proposed Side Mod Events Cumulative Decimal	(AR) Proposed Side Mod Events Cumulative Decimal	(AS) Proposed Side Mod Events Annual Decimal	(AT) Years of Incorporation	Events due to Unsch. Evt. allowing Mod.: (AU) Unsched Incorporation Opportunities Cumulative Decimal	(AV) Unsched Incorporation Opportunities Cumulative Integer	(AW) Unsched Incorporation Opportunities Annual Decimal	(AX) Kit Incorporation Events Unsched	(AY) Kit Incorporation Events Sched
0.00	1988	0.00	1988	0.00	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0	0.00	0.00	0.00
0.00	1989	0.00	1988	0.00	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0	0.00	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	0.24	0	0.24	0.24	0	0.24	0.00	0.00	0.00	0	0.24	0	0.24	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	1.02	1	0.78	1.02	1	0.78	0.00	0.00	0.00	0	1.02	1	0.78	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	2.40	2	1.38	2.40	2	1.38	0.00	0.00	0.00	0	2.40	2	1.38	0.00	0.00
0.00	1989	101,590.10	1989	0.00	101,590.10	4.43	4	2.03	4.43	4	2.03	0.00	0.00	0.00	0	4.43	4	2.03	0.00	0.00
0.00	1989	131,181.05	1989	0.00	131,181.05	7.05	7	2.62	7.05	7	2.62	0.00	0.00	0.00	1	7.05	7	2.62	1.06	54.66
0.00	1989	137,932.16	1989	10,690.23	148,622.40	10.02	10	2.97	9.81	9	2.76	0.02	0.02	0.02	1	9.81	9	2.76	2.76	137.93
0.00	1989	115,687.50	1989	38,263.36	153,950.87	13.10	13	3.08	12.12	12	2.31	0.10	0.10	0.08	1	12.12	12	2.31	2.31	115.68
0.00	1989	83,918.28	1989	69,306.41	153,224.69	16.17	16	3.06	13.80	13	1.68	0.24	0.24	0.14	1	13.80	13	1.68	1.68	83.92
0.00	1989	58,749.31	1989	93,738.16	152,487.47	19.22	19	3.05	14.98	14	1.17	0.42	0.42	0.19	1	14.98	14	1.17	1.17	58.75
0.00	1989	40,553.08	1989	111,200.87	151,753.76	22.25	22	3.04	15.79	15	0.81	0.65	0.65	0.22	1	15.79	15	0.81	0.81	40.55
0.00	1989	27,888.30	1989	123,365.29	151,023.58	25.27	25	3.02	16.34	16	0.55	0.89	0.89	0.25	1	16.34	16	0.55	0.55	27.67
0.00	1989	18,591.33	1989	131,705.58	150,298.92	28.28	28	3.01	16.71	16	0.37	1.16	1.16	0.26	1	16.71	16	0.37	0.37	18.59
0.00	1989	12,205.88	1989	137,367.76	149,573.75	31.27	31	2.99	16.96	16	0.24	1.43	1.43	0.27	1	16.96	16	0.24	0.24	12.21
0.00	1989	7,716.70	1989	141,137.35	148,854.06	34.25	34	2.98	17.11	17	0.15	1.71	1.71	0.28	1	17.11	17	0.15	0.15	7.72
0.00	1989	4,[illegible]1.84	1989	143,575.89	148,137.83	37.21	37	2.96	17.20	17	0.09	2.00	2.00	0.29	1	17.20	17	0.09	0.09	4.56
0.00	1989	2,[illegible]48.25	1989	145,078.80	147,426.05	40.16	40	2.95	17.25	17	0.05	2.29	2.29	0.29	1	17.25	17	0.05	0.05	2.36
0.00	1989	781.34	1989	145,924.36	146,715.70	43.09	43	2.93	17.27	17	0.02	2.58	2.58	0.29	1	17.27	17	0.02	0.00	0.79
0.00	1989	0.00	1989	146,009.76	146,009.76	46.01	46	2.92	17.27	17	0.00	2.87	2.87	0.29	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	145,307.22	145,307.22	48.92	48	2.91	17.27	17	0.00	3.17	3.17	0.29	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	144,808.06	144,808.06	51.81	51	2.89	17.27	17	0.00	3.45	3.45	0.29	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	132,992.26	132,992.26	54.47	54	2.66	17.27	17	0.00	3.72	3.72	0.27	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	107,726.02	107,726.02	56.63	56	2.15	17.27	17	0.00	3.94	3.94	0.22	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	79,788.30	79,788.30	58.22	58	1.60	17.27	17	0.00	4.10	4.10	0.16	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	49,218.27	49,218.27	59.21	59	0.98	17.27	17	0.00	4.19	4.19	0.10	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	21,548.65	21,548.65	59.64	59	0.43	17.27	17	0.00	4.24	4.24	0.04	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	5,255.26	5,255.26	59.74	59	0.11	17.27	17	0.00	4.25	4.25	0.01	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	59.74	59	0.00	17.27	17	0.00	4.25	4.25	0.00	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	59.74	59	0.00	17.27	17	0.00	4.25	4.25	0.00	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	59.74	59	0.00	17.27	17	0.00	4.25	4.25	0.00	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	59.74	59	0.00	17.27	17	0.00	4.25	4.25	0.00	0	17.27	17	0.00	0.00	0.00
0.00	1989	0.00	1989	0.00	0.00	59.74	59	0.00	17.27	17	0.00	4.25	4.25	0.00	0	17.27	17	0.00	0.00	0.00
								59.74			17.27			4.25	13			17.27	11.29	565.36

9999 Unmod Side Inspection Interval in TACs 3000
Unmod Side Inspection Interval in EFH 950.0
which is 3.958333 Years / Inspection Interval
and 0.252632 Inspections / Year

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

CURRENT CONFIGURATION

CEA VERSION 2.0 11/18/93
Pg. 3a

(BA) Calendar Year	(BC) Avg. No. Engines: Unmod Engines	(BD) Mod Engines	(BE) Yearly Engine Flight Hours: Unmod EFH (1000 EFH)	(BF) Mod EFH (1000 EFH)	(BG) Unsch. Events: Unmod	(BH) Mod	(BI) Sched. Events: Unmod	(BJ) Mod
1985	0.00		0.000		0.00		0.00	
1986	50.00		12.000		0.00		0.00	
1987	162.38		38.971		0.24		0.00	
1988	286.87		68.849		0.78		0.00	
1989	423.29		101.590		1.38		0.00	
1990	546.59		131.181		2.03		101.59	
1991	619.26		148.622		2.62		131.18	
1992	641.46		153.951		2.97		148.62	
1993	638.44		153.225		3.06		153.95	
1994	635.36		152.487		3.06		153.22	
1995	632.31		151.754		3.05		152.49	
1996	629.26		151.024		3.04		151.75	
1997	626.24		150.297		3.02		151.02	
1998	623.22		149.574		3.01		150.30	
1999	620.23		148.854		2.99		149.57	
2000	617.24		148.138		2.98		148.85	
2001	614.27		147.425		2.96		148.14	
2002	611.32		146.716		2.95		147.43	
2003	608.37		146.010		2.93		146.72	
2004	605.45		145.307		2.92		146.01	
2005	602.53		144.608		2.91		145.31	
2006	554.13		132.992		2.89		144.61	
2007	448.86		107.726		2.66		132.99	
2008	332.45		79.788		2.15		107.73	
2009	205.08		49.218		1.60		79.79	
2010	89.79		21.549		0.98		49.22	
2011	21.90		5.255		0.43		21.55	
2012	0.00		0.000		0.00		0.00	
2013	0.00		0.000		0.00		0.00	
2014	0.00		0.000		0.00		0.00	
2015	0.00		0.000		0.00		0.00	
2016	0.00		0.000		0.00		0.00	
2017	0.00		0.000		0.00		0.00	
Totals			2,987.111		59.64		2862.04	

(BA) Calendar Year	(BM) No. Installed	(BN) Engine Kits: Mat'l Cost $(000)	(BO) Labor Cost $(000)	(BP) No. Installed	(BQ) Spare Kits: Mat'l Cost $(000)	(BR) Labor Cost $(000)
1985						
1986						
1987						
1988						
1989						
1990						
1991						
1992						
1993						
1994						
1995						
1996						
1997						
1998						
1999						
2000						
2001						
2002						
2003						
2004						
2005						
2006						
2007						
2008						
2009						
2010						
2011						
2012						
2013						
2014						
2015						
2016						
2017						

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA   F-16
TASK/ECP: Task 000

CURRENT CONFIGURATION

CEA VERSION 2.0   [illegible]
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(BT) Calendar Year	(BU) One-Time Costs $(000)	(BW) Part Maint Cost Unmod $(000)	(BX) Part Maint Cost Mod $(000)	(BY) Unmod Unsch Cost (Minus Kit Instl) Labor $(000)	(BZ) Unmod Unsch Cost (Minus Kit Instl) Material $(000)	(CA) Unmod Sched Cost (Minus Kit Instl) Labor $(000)	(CB) Unmod Sched Cost (Minus Kit Instl) Material $(000)	(CC) Mod Unsched Cost Labor $(000)	(CD) Mod Unsched Cost Material $(000)	(CE) Mod Sched Cost Labor $(000)	(CF) Mod Sched Cost Material $(000)	(CG) Current Total Cost $(000)	(CH) Operational Fuel Gal/Yr (000)	(CI) Operational Fuel Cost $(000)	(CJ) Total Cost Curr Config w/ Fuel $(000)
1985		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
1986		$1.00		$0	$0	$0	$0					$1	N/A	N/A	$1
1987		$1.00		$0	$24	$0	$0					$26	N/A	N/A	$26
1988		$1.00		$1	$79	$0	$0					$81	N/A	N/A	$81
1989		$1.00		$2	$140	$0	$0					$143	N/A	N/A	$143
1990		$1.00		$3	$206	$159	$646					$1,015	N/A	N/A	$1,015
1991		$1.00		$4	$266	$205	$834					$1,311	N/A	N/A	$1,311
1992		$1.00		$5	$301	$232	$945					$1,485	N/A	N/A	$1,485
1993		$1.00		$5	$312	$241	$979					$1,538	N/A	N/A	$1,538
1994		$1.00		$5	$311	$240	$974					$1,531	N/A	N/A	$1,531
1995		$1.00		$5	$309	$239	$970					$1,523	N/A	N/A	$1,523
1996		$1.00		$5	$308	$237	$965					$1,516	N/A	N/A	$1,516
1997		$1.00		$5	$306	$236	$960					$1,509	N/A	N/A	$1,509
1998		$1.00		$5	$305	$235	$956					$1,501	N/A	N/A	$1,501
1999		$1.00		$5	$303	$234	$951					$1,494	N/A	N/A	$1,494
2000		$1.00		$5	$302	$233	$947					$1,487	N/A	N/A	$1,487
2001		$1.00		$5	$300	$232	$942					$1,480	N/A	N/A	$1,480
2002		$1.00		$5	$299	$231	$938					$1,473	N/A	N/A	$1,473
2003		$1.00		$5	$298	$229	$933					$1,466	N/A	N/A	$1,466
2004		$1.00		$5	$296	$228	$929					$1,459	N/A	N/A	$1,459
2005		$1.00		$5	$295	$227	$924					$1,452	N/A	N/A	$1,452
2006		$1.00		$5	$293	$226	$920					$1,445	N/A	N/A	$1,445
2007		$1.00		$4	$270	$208	$846					$1,329	N/A	N/A	$1,329
2008		$1.00		$3	$218	$169	$685					$1,076	N/A	N/A	$1,076
2009		$1.00		$2	$162	$125	$507					$797	N/A	N/A	$797
2010		$1.00		$2	$100	$77	$313					$492	N/A	N/A	$492
2011		$1.00		$1	$44	$34	$137					$216	N/A	N/A	$216
2012		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2013		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2014		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2015		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2016		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
2017		$0.00		$0	$0	$0	$0					$0	N/A	N/A	$0
Totals		$26.00		$93	$6,047	$4,477	$18,200					$28,843	0	$0	$28,843
$ (000) / Event used in the above columns:				$1.564	$101.390	$1.564	$6.359								

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA F-16
TASK/ECP: Task 000

PROPOSED CONFIGURATION

CEA VERSION 2.0 11/18/93
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(CM) Calendar Year	(CN) Engines Mod in Prod	(CO) Avg. No. Engines: Unmod Engines	(CP) Avg. No. Engines: Mod Engines	(CQ) Yearly Engine Flight Hours: Unmod EFH EFH / 1000	(CR) Yearly Engine Flight Hours: Mod EFH EFH / 1000	(CS) Unsch. Events: Unmod	(CT) Unsch. Events: Mod	(CU) Sched. Events: Unmod	(CV) Sched. Events: Mod	(CW) A/C Loss Events: Cum	(CX) A/C Loss Events: Annual	(CY) Engine Kits: No. Installed	(CZ) Engine Kits: Mat'l Cost $(000)	(DA) Engine Kits: Labor Cost $(000)	(DB) Spare Kits: No. Installed	(DC) Spare Kits: Mat'l Cost $(000)	(DD) Spare Kits: Labor Cost $(000)
1985	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
1986	0.00	50.00	0.00	12.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
1987	0.00	162.38	0.00	38.971	0.000	0.24	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
1988	0.00	286.87	0.00	68.849	0.000	0.78	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
1989	0.00	423.29	0.00	101.590	0.000	1.38	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
1990	0.00	546.59	0.00	131.181	0.000	2.03	0.00	101.59	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
1991	33.33	574.72	44.54	137.932	10.690	2.62	0.00	131.18	0.00	0.0	0.0	55.75	$836	$52	0.00	$0	$0
1992	0.00	482.03	159.43	115.688	38.263	2.76	0.02	137.93	8.02	0.0	0.0	140.69	$2,110	$131	0.00	$0	$0
1993	0.00	349.66	288.78	83.918	69.306	2.31	0.08	115.69	28.70	0.0	0.0	118.00	$1,770	$110	0.00	$0	$0
1994	0.00	244.79	390.58	58.749	93.738	1.68	0.14	83.92	51.98	0.0	0.0	85.60	$1,284	$80	0.00	$0	$0
1995	0.00	168.97	463.34	40.553	111.201	1.17	0.19	58.75	70.30	0.0	0.0	59.92	$899	$56	0.00	$0	$0
1996	0.00	115.28	513.98	27.668	123.355	0.81	0.22	40.55	83.40	0.0	0.0	41.36	$620	$38	0.00	$0	$0
1997	0.00	77.46	548.77	18.591	131.706	0.55	0.25	27.67	92.52	0.0	0.0	28.22	$423	$26	0.00	$0	$0
1998	0.00	50.86	572.37	12.206	137.368	0.37	0.26	18.59	98.78	0.0	0.0	18.96	$284	$18	0.00	$0	$0
1999	0.00	32.15	588.07	7.717	141.137	0.24	0.27	12.21	103.03	0.0	0.0	12.45	$187	$12	0.00	$0	$0
2000	0.00	19.01	598.23	4.562	143.576	0.15	0.28	7.72	105.85	0.0	0.0	7.87	$118	$7	0.00	$0	$0
2001	0.00	9.78	604.49	2.346	145.079	0.09	0.29	4.56	107.68	0.0	0.0	4.65	$70	$4	0.00	$0	$0
2002	0.00	3.30	608.02	0.791	145.924	0.05	0.29	2.35	108.81	0.0	0.0	2.39	$36	$2	0.00	$0	$0
2003	0.00	0.00	608.37	0.000	146.010	0.00	0.29	0.79	109.44	0.0	0.0	0.81	$12	$1	0.00	$0	$0
2004	0.00	0.00	605.45	0.000	145.307	0.00	0.29	0.00	109.51	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2005	0.00	0.00	602.53	0.000	144.608	0.00	0.29	0.00	108.98	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2006	0.00	0.00	554.13	0.000	132.992	0.00	0.29	0.00	108.46	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2007	0.00	0.00	448.86	0.000	107.726	0.00	0.27	0.00	99.74	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2008	0.00	0.00	332.45	0.000	79.788	0.00	0.22	0.00	80.79	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2009	0.00	0.00	205.08	0.000	49.218	0.00	0.16	0.00	59.84	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2010	0.00	0.00	89.79	0.000	21.549	0.00	0.10	0.00	36.91	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2011	0.00	0.00	21.90	0.000	5.255	0.00	0.04	0.00	16.16	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2012	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2013	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2014	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2015	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2016	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
2017	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00	0.0	0.0	0.00	$0	$0	0.00	$0	$0
Sub Totals	33.33			863.313	2,123.798	17.25	4.24	743.49	1588.91		0.0	576.69	$8,650	$537	0.00	$0	$0
Combined Unmodified & Modified Totals				2,987.111		21.49		2332.40									

	Total	$(000) / Kit
Kits Installed	577	"N/A"
Kit Material Cost	$8,650	$15.000
Kit Labor Cost	$537	$0.931

TITLE: CEA Test Input
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TASK/ECP: Task 000

PROPOSED CONFIGURATION

(DF)	(DG) One-Time Costs	(DH) Delta Prod. Cost	(DI) Part Maint Cost	(DJ)	(DK) Unmod Unsch Cost (Minus Kit Instl)	(DL)	(DM) Unmod Sched Cost (Minus Kit Instl)	(DN)	(DO) Mod Unsched Cost	(DP)	(DQ) Mod Sched Cost	(DR)	(DS) Proposed Total Cost	(DT) Operational Fuel	(DU)	(DV) A/C Loss Delta	(DW) Total Cost Prop Config w/ Fuel,A/C
Calendar Year	$(000)	$(000)	Unmod $(000)	Mod $(000)	Labor $(000)	Material $(000)	Labor $(000)	Material $(000)	Labor $(000)	Material $(000)	Labor $(000)	Material $(000)	$(000)	Gal/Yr (000)	Cost $(000)	$(000)	$(000)
1985	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
1986	$0	$0	$1.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$1	N/A	N/A	$0	$1
1987	$0	$0	$1.00	$0.00	$0	$24	$0	$0	$0	$0	$0	$0	$26	N/A	N/A	$0	$26
1988	$0	$0	$1.00	$0.00	$1	$79	$0	$0	$0	$0	$0	$0	$81	N/A	N/A	$0	$81
1989	$0	$0	$1.00	$0.00	$2	$140	$0	$0	$0	$0	$0	$0	$143	N/A	N/A	$0	$143
1990	$0	$0	$1.00	$0.00	$3	$206	$159	$646	$0	$0	$0	$0	$1,015	N/A	N/A	$0	$1,015
1991	$9	$333	$1.00	$1.00	$4	$266	$205	$834	$0	$0	$0	$0	$2,542	N/A	N/A	$0	$2,542
1992	$0	$0	$1.00	$1.00	$4	$280	$216	$877	$0	$2	$13	$9	$3,644	N/A	N/A	$0	$3,644
1993	$0	$0	$1.00	$1.00	$4	$235	$181	$736	$0	$8	$45	$34	$3,123	N/A	N/A	$0	$3,123
1994	$0	$0	$1.00	$1.00	$3	$170	$131	$534	$0	$14	$81	$62	$2,380	N/A	N/A	$0	$2,380
1995	$0	$0	$1.00	$1.00	$2	$119	$92	$374	$0	$19	$110	$83	$1,756	N/A	N/A	$0	$1,756
1996	$0	$0	$1.00	$1.00	$1	$82	$63	$258	$0	$22	$130	$99	$1,318	N/A	N/A	$0	$1,318
1997	$0	$0	$1.00	$1.00	$1	$56	$43	$176	$0	$25	$145	$110	$1,007	N/A	N/A	$0	$1,007
1998	$0	$0	$1.00	$1.00	$1	$38	$29	$118	$0	$27	$155	$117	$788	N/A	N/A	$0	$788
1999	$0	$0	$1.00	$1.00	$0	$25	$19	$78	$0	$28	$161	$122	$633	N/A	N/A	$0	$633
2000	$0	$0	$1.00	$1.00	$0	$16	$12	$49	$0	$28	$166	$125	$524	N/A	N/A	$0	$524
2001	$0	$0	$1.00	$1.00	$0	$9	$7	$29	$0	$29	$168	$128	$447	N/A	N/A	$0	$447
2002	$0	$0	$1.00	$1.00	$0	$5	$4	$15	$0	$29	$170	$129	$392	N/A	N/A	$0	$392
2003	$0	$0	$0.00	$1.00	$0	$0	$1	$5	$0	$29	$171	$130	$351	N/A	N/A	$0	$351
2004	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$29	$171	$130	$332	N/A	N/A	$0	$332
2005	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$29	$170	$129	$330	N/A	N/A	$0	$330
2006	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$29	$170	$128	$329	N/A	N/A	$0	$329
2007	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$27	$156	$118	$302	N/A	N/A	$0	$302
2008	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$22	$126	$96	$245	N/A	N/A	$0	$245
2009	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$16	$94	$71	$182	N/A	N/A	$0	$182
2010	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$10	$58	$44	$113	N/A	N/A	$0	$113
2011	$0	$0	$0.00	$1.00	$0	$0	$0	$0	$0	$4	$25	$19	$50	N/A	N/A	$0	$50
2012	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2013	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2014	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2015	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2016	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
2017	$0	$0	$0.00	$0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	N/A	N/A	$0	$0
Sub Totals	$9	$333	$17.00	$21.00	$27	$1,749	$1,163	$4,728	$7	$427	$2,485	$1,682	$22,034	0	$0	$0	$22,034
Combined Unmodified & Modified Totals			$38.00		$1,776		$5,891			$433		$4,367					
$ (000) / Event used in the above columns:					$1.564	$101.390	$1.564	$6.359	$1.564	$100.742	$1.564	$1.184					

TITLE: CEA Test Input
ENGINE MODEL: F110-GE-CEA
TASK/ECP: Task 000

CEA VERSION 2.0

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(DY) CAL. YEAR	(DZ) Expenditures Current $(000)	(EA) Proposed $(000)	(EB) Delta Cashflow Yearly Savings $(000)	(EC) Cumulative Savings $(000)	(ED) Cumulative NPV at 10% $(000)
1985	$0	$0	$0	$0	$0
1986	$1	$1	$0	$0	$0
1987	$26	$26	$0	$0	$0
1988	$81	$81	$0	$0	$0
1989	$143	$143	$0	$0	$0
1990	$1,015	$1,015	$0	$0	$0
1991	$1,311	$2,542	($1,231)	($1,231)	($1,231)
1992	$1,485	$3,644	($2,160)	($3,391)	($3,195)
1993	$1,538	$3,123	($1,586)	($4,976)	($4,505)
1994	$1,531	$2,360	($830)	($5,806)	($5,128)
1995	$1,523	$1,756	($232)	($6,039)	($5,287)
1996	$1,516	$1,318	$198	($5,840)	($5,164)
1997	$1,509	$1,007	$501	($5,339)	($4,881)
1998	$1,501	$788	$713	($4,626)	($4,515)
1999	$1,494	$633	$861	($3,765)	($4,114)
2000	$1,487	$524	$963	($2,803)	($3,705)
2001	$1,480	$447	$1,033	($1,770)	($3,307)
2002	$1,473	$392	$1,080	($689)	($2,928)
2003	$1,466	$351	$1,115	$425	($2,573)
2004	$1,459	$332	$1,127	$1,552	($2,247)
2005	$1,452	$330	$1,121	$2,673	($1,952)
2006	$1,445	$329	$1,116	$3,789	($1,684)
2007	$1,329	$302	$1,026	$4,816	($1,461)
2008	$1,076	$245	$831	$5,647	($1,297)
2009	$797	$182	$616	$6,263	($1,186)
2010	$492	$113	$380	$6,642	($1,124)
2011	$216	$50	$166	$6,809	($1,099)
2012	$0	$0	$0	$6,809	($1,099)
2013	$0	$0	$0	$6,809	($1,099)
2014	$0	$0	$0	$6,809	($1,099)
2015	$0	$0	$0	$6,809	($1,099)
2016	$0	$0	$0	$6,809	($1,099)
2017	$0	$0	$0	$6,809	($1,099)
Totals	$28,843	$22,034	$6,809		
NPV	$14,911	$16,010	($1,099)		

Base Year is 1991
NPV Rate 10%

APPENDIX C

COST DRIVER ANALYSIS - CEAMOD

Appendix C is a summary of the results of a cost driver analysis performed using CEAMOD Version 2.0.

COST DRIVER ANALYSIS – CEAMOD

Cell	Input Element	Base Value	Comparison Value	Current Configuration Total Cost (000's) (Cell CG48)	Proposed Configuration Total Cost (000's) (Cell DS48)	Difference Current – Proposed Total Cost (000's)	% Change in Proposed Cost compared to Base Proposed Costs
D9	Incorporation Style	2	1	$29,332	$22,538	$6,794	0.00%
		2	Base Value	$29,332	$22,538	$6,794	
		2	3	$29,332	$28,471	$861	26.32%
D15	Delta Production Cost	$10,000.00	$20,000.00	$29,332	$22,868	$6,464	1.46%
D16	Kit Hardware Cost – $/Engine	$15,000.00	$30,000.00	$29,332	$31,193	($1,861)	38.40%
D17	Kit Labor Manhours at O&I	2	4	$29,332	$22,575	$6,757	0.16%
D18	Kit Labor Manhours at Depot	20	40	$29,332	$23,067	$6,265	2.35%
G11	Labor Cost / Manhour at O&I	$32.32	$64.64	$33,005	$25,551	$7,454	13.37%
G12	Labor Cost / Manhour at Depot	$43.30	$86.60	$30,627	$24,087	$6,540	6.87%
D19	Technical Pubs Cost – Total $	$500.00	$1,000.00	$29,332	$22,538	$6,794	0.00%
D20	TCTO Cost – Total $	$1,500.00	$3,000.00	$29,332	$22,539	$6,793	0.00%
G14	Cost to introduce new P/N – $/PN	$1,524.00	$3,048.00	$29,332	$22,544	$6,788	0.03%
G15	Cost to Maintain each P/N / Year	$250.00	$500.00	$29,358	$22,576	$6,782	0.17%
D21	Tooling/Support Equipment Cost – Total $	$500.00	$1,000.00	$29,332	$22,538	$6,794	0.00%
G17	Fuel Cost / Gallon	$0.61	$1.22	$29,742	$22,870	$6,872	1.47%
G19	Test Fuel – Gallons / Hour	150	300	$29,332	$22,538	$6,794	0.00%
D22	Spare Parts Factor	0%	100%	$29,332	$32,255	($2,923)	43.11%
D29	Field Incorporation Date – Year	1991	1993	$29,332	$24,491	$4,841	8.67%
D24	Scheduled % Events being Modified	100%	200%	$29,332	$21,138	$8,194	-6.21%
D25	Unscheduled % Events being Modified	100%	200%	$29,332	$22,509	$6,823	-0.13%
D26	Unscheduled Event Rate allowing Modification	0.02	0.04	$29,332	$22,487	$6,845	-0.23%
D28	Production Incorporation Date – Year	1991	1993	$29,332	$22,886	$6,446	1.54%

APPENDIX D

COST DRIVER ANALYSIS - NON-INTEGERIZED CEAMOD

Appendix C is a summary of the results of a cost driver analysis performed using the non-integerized revision to CEAMOD Version 2.0.

COST DRIVER ANALYSIS – REVISED (NON–INTEGERIZED) CEAMOD

Cell	Input Element	Base Value	Comparison Value	Current Configuration Total Cost (000's) (Cell CG48)	Proposed Configuration Total Cost (000's) (Cell DS48)	Difference Current – Proposed Total Cost (000's)	% Change in Proposed Cost compared to Base Proposed Costs
D9	Incorporation Style	2	1	$28,843	$22,034	$6,809	0.00%
		2	Base Value	$28,843	$22,034	$6,809	
		2	3	$28,843	$27,973	$870	26.95%
D15	Delta Production Cost	$10,000.00	$20,000.00	$28,843	$22,368	$6,475	1.52%
D16	Kit Hardware Cost – $/Engine	$15,000.00	$30,000.00	$28,843	$30,685	($1,842)	39.26%
D17	Kit Labor Manhours at O&I	2	4	$28,843	$22,072	$6,771	0.17%
D18	Kit Labor Manhours at Depot	20	40	$28,843	$22,534	$6,309	2.27%
G11	Labor Cost / Manhour at O&I	$32.32	$64.64	$32,431	$24,963	$7,468	13.29%
G12	Labor Cost / Manhour at Depot	$43.30	$86.60	$30,108	$23,553	$6,555	6.89%
D19	Technical Pubs Cost – Total $	$500.00	$1,000.00	$28,843	$22,035	$6,808	0.00%
D20	TCTO Cost – Total $	$1,500.00	$3,000.00	$28,843	$22,036	$6,807	0.01%
G14	Cost to introduce new P/N – $/PN	$1,524.00	$3,048.00	$28,843	$22,041	$6,802	0.03%
G15	Cost to Maintain each P/N / Year	$250.00	$500.00	$28,869	$22,072	$6,797	0.17%
D21	Tooling/Support Equipment Cost – Total $	$500.00	$1,000.00	$28,843	$22,035	$6,808	0.00%
G17	Fuel Cost / Gallon	$0.61	$1.22	$29,244	$22,357	$6,887	1.47%
G19	Test Fuel – Gallons / Hour	150	300	$28,843	$22,034	$6,809	0.00%
D22	Spare Parts Factor	0%	100%	$28,843	$31,752	($2,909)	44.10%
D29	Field Incorporation Date – Year	1991	1993	$28,843	$24,098	$4,745	9.37%
D24	Scheduled % Events being Modified	100%	200%	$28,843	$20,665	$8,178	–6.21%
D25	Unscheduled % Events being Modified	100%	200%	$28,843	$21,971	$6,872	–0.29%
D26	Unscheduled Event Rate allowing Modification	0.02	0.04	$28,843	$21,971	$6,872	–0.29%
D28	Production Incorporation Date – Year	1991	1993	$28,843	$22,454	$6,389	1.91%

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